NOV 7 1947

SAE JOURNAL

In this issue:

NEW Steel SPECS

Articles on: Tractor and Aero Meetings... Rockets... Torsion Bars ... Hydraulics... Spark Plugs

NOVEMBER 1947

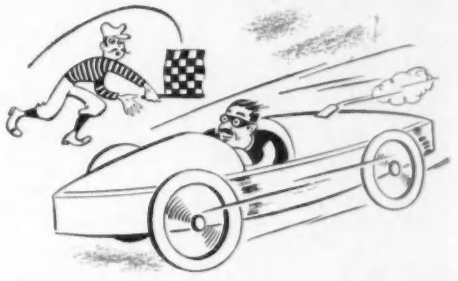
Rumor Page

IT'S RUMORED THAT

Our face is RED!

That's right—it is. In a recent rumor we stated that the automobile record in 1909 was held by Barney Oldfield driving the Ford 999. It just ain't so. It was January 4, 1903, that Henry Ford, driving the 999, covered the mile at 91.370 m.p.h. The record 1906-'09 was held by Fred Marriott driving a Stanley Steamer. The speed was 127.659 m.p.h.

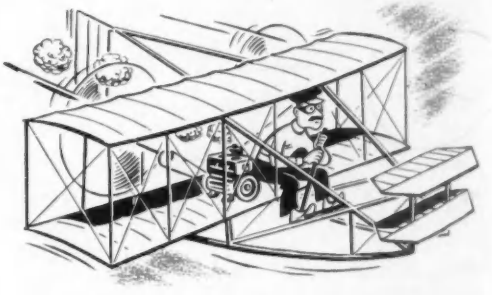
Correction by: Smith Hempstone Oliver
Smithsonian Institute, Washington, D. C.



IT'S RUMORED THAT

Gasoline engines without carburetors are nothing new.

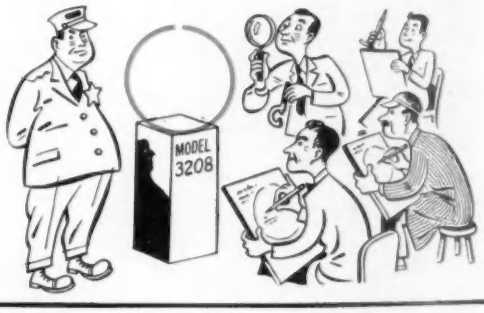
That's right. Even the engine in the old Wright airplane that made history at Kitty Hawk had a "drip system" of fuel injection—and no carburetor. Today, some engineers are again favoring straight fuel injection more and more, at least for specialized types of engines—so it isn't entirely a new idea.



IT'S RUMORED THAT

The first quick seating oil ring was made by Perfect Circle!

Right! It's another Perfect Circle first! The 3208 face, developed and perfected by Perfect Circle, has served as a model for the whole industry. It is just one Perfect Circle development, but it reflects the painstaking research and laboratory work that goes on at Perfect Circle all the time.



IT'S RUMORED THAT

The A.S.I. Show in Chicago this year will be the biggest and best yet!

It's bound to be. There are a lot of new developments since last year, and the Automotive Service Industry Show is where they will show up. 476 exhibitors will use over 153,000 square feet of space to show their latest and best. The dates are December 8 through 13—the place is Navy Pier, Chicago.

Perfect Circle Corporation, makers of Perfect Circle *Custom Made* Piston Ring Sets, will pay fifty dollars ($50) for each rumor, fact or fiction, accepted for this page. Send your rumor to Rumor Page, Perfect Circle, Hagerstown 9, Indiana. All contributions become our property and cannot be returned or acknowledged.

The Cover

● Floor sections of passenger cars leaving the forming press toward the subassembly line on their way to the body assembly line.

Here the sections are aligned on the endless chain conveyor toward stations where fittings will be installed and the semi-assembled floor sections will be painted before the seats, upholstery, side and top panels are added.

For the Sake of Argument

By NORMAN G. SHIDLE

"First I light a match. Then I build a bridge."

That's how a gifted minister once answered the question: "How do you hold the attention of your audience?"

His simple, profound formula is the Alpha and Omega of good business writing. Letters, reports, speeches, professional society papers, sales promotion documents, minutes of committee meetings, business paper articles . . . all of them get information or inspiration from the writer to the reader if they first light a match; then build a bridge – in that order.

If the reader doesn't see a light to start with, he may not stay to see the bridge built. If his attention is attracted by a light that turns out to illuminate nothing, he turns aside in boredom or disappointment.

The surest way for the average businessman-writer to light a match is to state as specifically as possible in his first sentence the one main idea he hopes to leave with his reader. There are many other ways, but none so widely applicable or so well within the ability of the non-professional scrivener.

Once that main idea is clearly, specifically stated, the approaches to one end of the bridge have already been built. The other end is the reader's mind. With the two fixed points established, the bridge can be built with a minimum of time and material . . . and isn't so likely to end up a circular staircase.

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SAE Journal Honored . . . .

SAE Journal has just received a first prize for best format design in the Annual Business Paper Editorial Awards sponsored by "Industrial Marketing."

Leading technical and business publications of the country make entries in this contest.

The award was officially presented at a dinner meeting of the Industrial Advertisers Association in New York on Oct. 20.

Chairman, SAE Publication Committee

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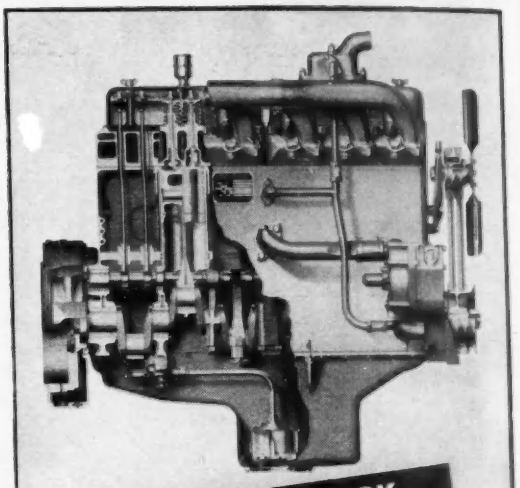

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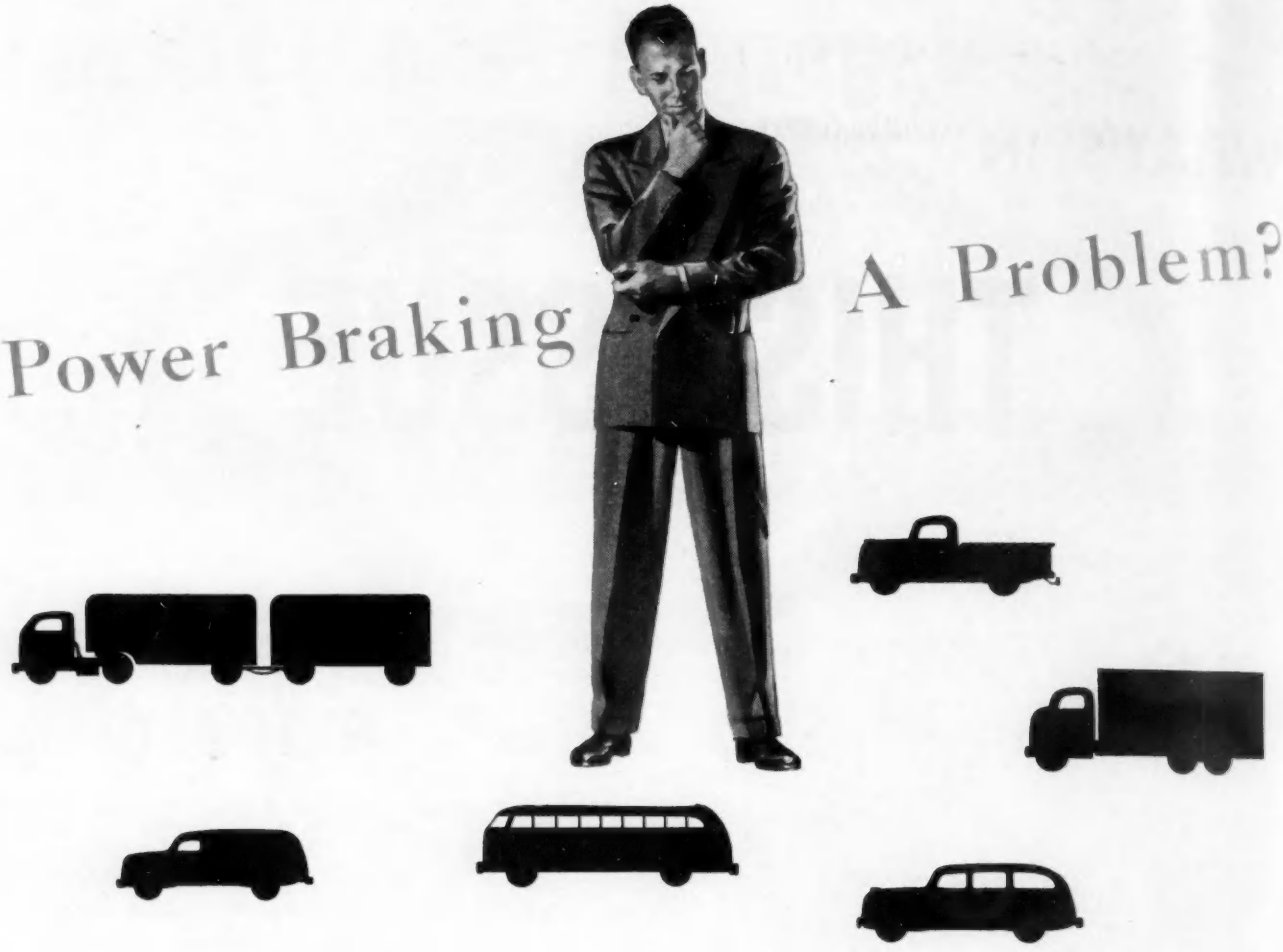
Power Braking A Problem?



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POSTWAR SAE STEELS

Expanded Steel Specification Tables Reflect Current Automotive Practice

THE addition of 55 new compositions and deletion of 47 numbers and compositions from the SAE Steel lists have recently been approved by the SAE Technical Board. This work represents an historic advance in steel specifications and offers automotive users a wider range of standard compositions. (The new lists are being printed for the first time in this issue of the SAE Journal. They will appear in the 1948 SAE Handbook.)

All but three of the deletions were NE (wartime National Emergency) steels. In the 1000 Series Carbon steel list 10 steels were added and two deleted; 11 steels were added and none deleted in the 1100 Free Cutting steel list; 30 added and one deleted in the Alloy lists; the former NE steels, which have been retained and in the future will carry SAE prefixes, show an addition of 4 steels with 44 deletions.

Technical Board Sponsor of the ISTC is Board Member R. H. McCarroll, Ford Motor Co. General Chairman of the ISTC for 1947 is Glen C. Riegel, Caterpillar Tractor Co. Active direction of ISTC policy and projects is in the hands of the ISTC Executive Committee. Efforts of the ISTC during the past year have brought viewpoints of the producers and users on steel standardization closer than ever before.

More than a year ago, producers through the American Iron & Steel Institute and users through the SAE agreed that neither organization in the future would change the composition or numbering of steels listed by either group without first giving the other organization an opportunity to study and discuss the matter. The object, of course, was to bring the lists and compositions of the two organizations into as complete agreement as possible. Advantages of such an arrangement to both producers and users are evident. How well this has been brought about will be readily seen by a comparison of the new SAE tables with the latest tables of the AISI. Such an agreement will be of material assistance to the armed forces.

As a result of the work done by Division VII – 1000 Series Carbon Steels; Division VIII – 1100 Steels; Division XIV – Alloy Steels on which producers and users have been equally represented, almost all SAE steels are now AISI Standard Steels. To accomplish this AISI has added many numbers and compositions at users' (SAE) request. In other instances SAE compositions were altered to agree with AISI compositions, but only after a full discussion by competent metallurgists of both users and producers.

Coordinate Activities

Out of this close cooperation was born an AISI-SAE Liaison Committee with three members from each group. SAE members of the Liaison Committee are G. C. Riegel, Caterpillar Tractor Co., and general chairman of the ISTC; E. H. Stilwill, Chrysler Corp. and chairman of Panel C – Automotive, and Division XIV – Alloy Steels, and L. A. Danse, General Motors Corp. and chairman of Panel E – Miscellaneous Users. AISI members are L. W. Winkler, Bethlehem Steel Co. and chairman of the AISI General Technical Committee; Charles Parker, secretary of the General Technical Committee, and P. R. Wray, Carnegie-Illinois Steel Corp., and chairman of the AISI Alloy Steel Committee.

Some matters now before the Liaison Committee are: surveys of steel tonnage and base line bogeys for determining what constitutes a Standard Steel; Numbering of "B" and "C" grades of steel; complete review of Check Analysis of carbon steels; clarification and possible expansion of definitions and descriptions of Bar Quality steels, and means of keeping users up to date on the current vital alloy situation.

TABLE 1—CARBON STEELS (See Notes 1 and 2)

These compositions are applicable only to semi-finished products, bars (hot rolled and cold finished), wire rods and hot rolled strip.

SAE Number	Nominal Chemical Ranges				Corresp. AISI Number
	C	Mn	P Max.	S Max.	
1006	0.08 max.	0.25–0.40	0.040	0.050	C1006
1008	0.10 max.	0.25–0.50	0.040	0.050	C1008
1010	0.08–0.13	0.30–0.60	0.040	0.050	C1010
1015	0.13–0.18	0.30–0.60	0.040	0.050	C1015
1016	0.13–0.18	0.60–0.90	0.040	0.050	C1016
1017	0.15–0.20	0.30–0.60	0.040	0.050	C1017
1018	0.15–0.20	0.60–0.90	0.040	0.050	C1018
1019	0.15–0.20	0.70–1.00	0.040	0.050	C1019
1020	0.18–0.23	0.30–0.60	0.040	0.050	C1020
1022	0.18–0.23	0.70–1.00	0.040	0.050	C1022
1024	0.19–0.25	1.35–1.65	0.040	0.050	C1024
1025	0.22–0.28	0.30–0.60	0.040	0.050	C1025
1027	0.22–0.29	1.20–1.50	0.040	0.050	C1027
1030	0.28–0.34	0.60–0.90	0.040	0.050	C1030
1033	0.30–0.36	0.70–1.00	0.040	0.050	C1033
1034	0.32–0.38	0.50–0.80	0.040	0.050	C1034
1035	0.32–0.38	0.60–0.90	0.040	0.050	C1035
1036	0.30–0.37	1.20–1.50	0.040	0.050	C1036
1038	0.35–0.42	0.60–0.90	0.040	0.050	C1038
1040	0.37–0.44	0.60–0.90	0.040	0.050	C1040
1041	0.36–0.44	1.35–1.65	0.040	0.050	C1041
1042	0.40–0.47	0.60–0.90	0.040	0.050	C1042
1043	0.40–0.47	0.70–1.00	0.040	0.050	C1043
1045	0.43–0.50	0.60–0.90	0.040	0.050	C1045
1046	0.43–0.50	0.70–1.00	0.040	0.050	C1046
1050	0.48–0.55	0.60–0.90	0.040	0.050	C1050
1052	0.47–0.55	1.20–1.50	0.040	0.050	C1052
1055	0.50–0.60	0.60–0.90	0.040	0.050	C1055
1060	0.55–0.65	0.60–0.90	0.040	0.050	C1060
1062	0.54–0.65	0.85–1.15	0.040	0.050	C1062
1064	0.60–0.70	0.50–0.80	0.040	0.050	C1064
1065	0.60–0.70	0.60–0.90	0.040	0.050	C1065
1066	0.60–0.71	0.85–1.15	0.040	0.050	C1066
1070	0.65–0.75	0.60–0.90	0.040	0.050	C1070
1074	0.70–0.80	0.50–0.80	0.040	0.050	C1074
1078	0.72–0.85	0.30–0.60	0.040	0.050	C1078
1080	0.75–0.88	0.60–0.90	0.040	0.050	C1080
1085	0.80–0.93	0.70–1.00	0.040	0.050	C1085
1090	0.85–1.00	0.60–0.90	0.040	0.050	C1090
1095	0.90–1.05	0.30–0.50	0.040	0.050	C1095

NOTE.—See Notes 1 and 2 following Table 10.

Details of the work of the five Panels and 28 Divisions of the Iron and Steel Technical Committee are too great even to be summarized in this brief article.

1000 Series Carbon Steel Revisions

The new 1000 Series Carbon Steel list reproduced on these pages is the result of several meetings and attendant discussions of Division VII, Panel C – Automotive Users, Panel D – Tractor and Earth Moving Equipment Users and two meetings of the ISTC Executive Committee. Two letter ballots were required to bring about agreement with respect to additions, deletions and revisions of compositions. Ten steels were added and two of the current list deleted. The additions are 1024, 1027, 1034, 1036, 1038, 1041, 1042, 1043, 1046 and 1065. Deletions are 1026 and 1086.

1000 Series Carbon Steels are now shown in Table I, page 283, 1947 Handbook.

Chairman of Division VII which handled the Carbon Steel revisions is H. W. Browall, Inland Steel Co. Other members of the Division are: George Breyer, Crucible Steel Co. of America; C. A. Burkhalter, Wheeling Steel Corp.; A. F. Christian, Wyman-Gordon Co.; E. H. Davidson, Carnegie-Illinois Steel Corp.; J. D. Dickerson, Republic Steel Corp.; M. F. Garwood, Chrysler Corp.; W. J. Harris, Studebaker Corp.; V. E. Hense, Buick Motor Division, GMC; E. L. Hollady, ORDTB-Materials Branch, Ordnance Department, U. S. Army; J. T. Jarman, Allis-Chalmers Mfg. Co.; C. L. Kent, Jones & Laughlin Steel Corp.; R. E. McGee, International Harvester Co.; H. A. Moorhead, Carnegie-Illinois Steel Corp.; J. E. Spittle, Ford Motor Co.; J. R. Thompson, American Steel & Wire Co.; R. S. Thompson, Washburn Wire Co.; R. E. VanDeventer, Packard Motor Car Co.; F. F. Vaughn, Caterpillar Tractor Co.; C. W. Weesner, Sharon Steel Corp.; C. W. Wheatley, A. O. Smith Corp.; and Henry Wysor, Bethlehem Steel Co.

TABLE 2—FREE CUTTING STEELS (See Notes 1 and 2)

Applicable only to blooms, billets, slabs, bars and rods. Basic open hearth and acid bessemer resulphurized carbon steels.

Subject to Permissible Variations for Check Analysis. (Resulphurized Steel is not subject to check analysis for sulphur).

SAE Number	Nominal Chemical Ranges				Corresp. AISI Number
	C	Mn	P	S	
Bessemer					
1111	0.13 Max.	0.60–0.90	0.07–0.12	0.08–0.15	B1111
1112	0.13 Max.	0.70–1.00	0.07–0.12	0.16–0.23	B1112
1113	0.13 Max.	0.70–1.00	0.07–0.12	0.24–0.33	B1113
Open Hearth			Max.		
1109	0.08–0.13	0.60–0.90	0.045	0.08–0.13	C1109
1114	0.10–0.16	1.00–1.30	0.045	0.08–0.13	C1114
1115	0.13–0.18	0.60–0.90	0.045	0.08–0.13	C1115
1116	0.14–0.20	1.10–1.40	0.045	0.16–0.23	C1116
1117	0.14–0.20	1.00–1.30	0.045	0.08–0.13	C1117
1118	0.14–0.20	1.30–1.60	0.045	0.08–0.13	C1118
1119	0.14–0.20	1.00–1.30	0.045	0.24–0.33	C1119
1120	0.18–0.23	0.70–1.00	0.045	0.08–0.13	C1120
1126	0.23–0.29	0.70–1.00	0.045	0.08–0.13	C1126
1132	0.27–0.34	1.35–1.65	0.045	0.08–0.13	....
1137	0.32–0.39	1.35–1.65	0.045	0.08–0.13	C1137
1138	0.34–0.40	0.70–1.00	0.045	0.08–0.13	C1138
1140	0.37–0.44	0.70–1.00	0.045	0.08–0.13	C1140
1141	0.37–0.45	1.35–1.65	0.045	0.08–0.13	C1141
1144	0.40–0.48	1.35–1.65	0.045	0.24–0.33	C1144
1145	0.42–0.49	0.70–1.00	0.045	0.04–0.07	C1145
1146	0.42–0.49	0.70–1.00	0.045	0.08–0.13	C1146
1151	0.48–0.55	0.70–1.00	0.045	0.08–0.13	C1151

TABLE 3—MANGANESE STEELS (See Note 3)

SAE Number	Nominal Chemical Ranges					Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	
1320	0.18–0.23	1.60–1.90	0.040	0.040	0.20–0.35	1320
1330	0.28–0.33	1.60–1.90	0.040	0.040	0.20–0.35	1330
1335	0.33–0.38	1.60–1.90	0.040	0.040	0.20–0.35	1335
1340	0.38–0.43	1.60–1.90	0.040	0.040	0.20–0.35	1340

The complete list of 1000 Series Carbon Steels which will replace Table I, page 283 of the 1947 SAE Handbook, is included with this article.

This list of steels was thoroughly studied and reviewed by Division VIII – 1100 Series Steels; Panel C – Automotive Users; Panel D – Tractor and Earth Moving Equipment and the ISTC Executive Committee. A number of steels carried as company specifications by large users were reviewed and their usage checked. Some of them were added to the SAE list. SAE

TABLE 4—NICKEL STEELS (See Note 3)

SAE Number	Nominal Chemical Ranges						Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	Ni	
2317	0.15–0.20	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	2317
2330	0.28–0.33	0.60–0.80	0.040	0.040	0.20–0.35	3.25–3.75	2330
2340	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	3.25–3.75	2340
2345	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	3.25–3.75	2345
2512[4]	0.09–0.14	0.45–0.60	0.025	0.025	0.20–0.35	4.75–5.25	E2512
2515	0.12–0.17	0.40–0.60	0.040	0.040	0.20–0.35	4.75–5.25	2515
2517[4]	0.15–0.20	0.45–0.60	0.025	0.025	0.20–0.35	4.75–5.25	E2517

NOTE.—See Notes 1, 2 and 3 following Table 10.
[4] Electric Furnace Steel

Where there is no prefix in AISI number the steel is predominately open hearth.

TABLE 5—NICKEL CHROMIUM STEELS (See Note 3)

SAE Number	Nominal Chemical Ranges							Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	Ni	Cr	
3115	0.13–0.18	0.40–0.60	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	3115
3120	0.17–0.22	0.60–0.80	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	3120
3130	0.28–0.33	0.60–0.80	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	3130
3135	0.33–0.38	0.60–0.80	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	3135
3140	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.55–0.75	3140
3141	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.70–0.90	3141
3145	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.70–0.90	3145
3150	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	1.10–1.40	0.70–0.90	3150
3310[4]	0.08–0.13	0.45–0.60	0.025	0.025	0.20–0.35	3.25–3.75	1.40–1.75	E3310
3316[4]	0.14–0.19	0.45–0.60	0.025	0.025	0.20–0.35	3.25–3.75	1.40–1.75	E3316

[4] Electric Furnace steel.

TABLE 6—MOLYBDENUM STEELS (See Note 3)

SAE Number	Nominal Chemical Ranges								Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo	
4017	0.15–0.20	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4017
4023	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4023
4024	0.20–0.25	0.70–0.90	0.040	.035 to .050	0.20–0.35	....	....	0.20–0.30	4024
4027	0.25–0.30	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4027
4028	0.25–0.30	0.70–0.90	0.040	.035 to .050	0.20–0.35	....	....	0.20–0.30	4028
4032	0.30–0.35	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4032
4037	0.35–0.40	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4037
4042	0.40–0.45	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4042
4047	0.45–0.50	0.70–0.90	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4047
4053	0.50–0.56	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4053
4063	0.60–0.67	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4063
4068	0.63–0.70	0.75–1.00	0.040	0.040	0.20–0.35	....	....	0.20–0.30	4068
4119	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	....	0.40–0.60	0.20–0.30	4119
4125	0.23–0.28	0.70–0.90	0.040	0.040	0.20–0.35	....	0.40–0.60	0.20–0.30	4125
4130	0.28–0.33	0.40–0.60	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4130
4137	0.35–0.40	0.70–0.90	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4137
4140	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4140
4145	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4145
4150	0.48–0.53	0.75–1.00	0.040	0.040	0.20–0.35	....	0.80–1.10	0.15–0.25	4150
4317	0.15–0.20	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	0.40–0.60	0.20–0.30	4317
4320	0.17–0.22	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	0.40–0.60	0.20–0.30	4320
4340	0.38–0.43	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	0.70–0.90	0.20–0.30	4340
4608	0.06–0.11	0.45 max	0.040	0.040	0.25 max	1.40–1.75	....	0.15–0.25	4608
4615	0.13–0.18	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4615
4617	0.15–0.20	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	....
4620	0.17–0.22	0.45–0.65	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4620
4620	0.18–0.23	0.50–0.70	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	....
4621	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4621
4640	0.38–0.43	0.60–0.80	0.040	0.040	0.20–0.35	1.65–2.00	....	0.20–0.30	4640
4812	0.10–0.15	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	....	0.20–0.30	4812
4815	0.13–0.18	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	....	0.20–0.30	4815
4817	0.15–0.20	0.40–0.60	0.040	0.040	0.20–0.35	3.25–3.75	....	0.20–0.30	4817
4820	0.18–0.23	0.50–0.70	0.040	0.040	0.20–0.35	3.25–3.75	....	0.20–0.30	4820

NOTE.—See Notes 1, 2 and 3 following Table 10.

Where there is no prefix in AISI number the steel is predominately open hearth.

and AISI lists are now virtually in 100% agreement with respect to compositions. The new 1100 Series SAE list contains twenty-one steels compared to eleven steels in the list contained in the 1947 SAE Handbook.

Division VIII which handled the 1100 Series Steels revision is headed by J. D. Armour, Union Drawn Steel Division of Republic Steel Corp. Other members of the Division are: H. Bornstein, Deere & Co.; R. J. Griffin, Saginaw Steering Gear Division, GMC; E. L. Hollady, ORDTB-Materials Branch, Ord. Dept., U. S. Army; A. S. Jameson, International Harvester Co.; C. L. Kent, Jones & Laughlin Steel Corp.; E. O. Mann, Chevrolet Motor Division; H. A. Moorhead, Carnegie-Illinois Steel Corp.; R. J. Peters, Warner Gear Division, Borg-Warner Corp.; J. E. Spittle, Ford Motor Co.; and Henry Wysor, Bethlehem Steel Co.

TABLE 7—CHROMIUM STEELS (See Note 3)

SAE Number	Nominal Chemical Ranges						Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	Cr	
5045	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	0.55–0.75	5045
5046	0.43–0.50	0.75–1.00	0.040	0.040	0.20–0.35	0.20–0.35	5046
5115	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	0.70–0.90	....
5120	0.17–0.22	0.70–0.90	0.040	0.040	0.20–0.35	0.70–0.90	5120
5130	0.28–0.33	0.70–0.90	0.040	0.040	0.20–0.35	0.80–1.10	5130
5132	0.30–0.35	0.60–0.80	0.040	0.040	0.20–0.35	0.80–1.05	5132
5135	0.33–0.38	0.60–0.80	0.040	0.040	0.20–0.35	0.80–1.05	5135
5140	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	0.70–0.90	5140
5145	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	0.70–0.90	5145
5147	0.45–0.52	0.75–1.00	0.040	0.040	0.20–0.35	0.90–1.20	5147
5150	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	0.70–0.90	5150
5152	0.48–0.55	0.70–0.90	0.040	0.040	0.20–0.35	0.90–1.20	5152
50100[4]	0.95–1.10	0.25–0.45	0.025	0.025	0.20–0.35	0.40–0.60	E50100
51100[4]	0.95–1.10	0.25–0.45	0.025	0.025	0.20–0.35	0.90–1.15	E51100
52100[4]	0.95–1.10	0.25–0.45	0.025	0.025	0.20–0.35	1.30–1.60	E52100

[4] Electric Furnace Steel.

TABLE 8—CHROMIUM VANADIUM STEEL (See Note 3)

SAE Number	Nominal Chemical Ranges							Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	Cr	V Min.	
6150	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	0.80–1.10	0.15	6150

TABLE 9—SILICON MANGANESE STEEL (See Note 3)

SAE Number	Nominal Chemical Ranges						Corresp. AISI Number
	C	Mn	P Max.	S Max.	Si	Cr	
9254	0.50–0.60	0.50–0.80	0.040	0.040	1.20–1.60	0.50–0.80	....
9255	0.50–0.60	0.70–0.95	0.040	0.040	1.80–2.20	.....	9255
9260	0.55–0.65	0.70–1.00	0.040	0.040	1.80–2.20	.....	9260
9261	0.55–0.65	0.75–1.00	0.040	0.040	1.80–2.20	0.10–0.25	9261
9262	0.55–0.65	0.75–1.00	0.040	0.040	1.80–2.20	0.25–0.40	9262

NOTE 1.—For standard variations in composition limits, refer to Table 13, Standard Variations, Open Hearth and Acid Bessemer Carbon Steel Bars.

NOTE 2.—When silicon is specified in standard basic open hearth steels, silicon may be ordered only as 0.10 per cent maximum; in grades up to SAE 1010 incl.; 0.10 per cent max., 0.10–0.20, or 0.15–0.30 per cent in grades from SAE 1015 to 1025 incl.; and 0.10–0.20 or 0.15–0.30 for grades over SAE 1025. In the case of many grades of basic open hearth steel, special practice is necessary in order to comply with a specification including silicon. Acid bessemer steel is not furnished with specified silicon content.

NOTE 3.—For standard variations in composition limits, refer to Table 14, Standard Variations, Open Hearth Alloy and Electric Furnace Steel Bars and Billets.

Where there is no prefix in AISI number the steel is predominately open hearth.

The complete list of 1100 Series Free Cutting Steels which will replace Table 2 – on page 284 of the 1947 SAE Handbook is included with this article.

Alloy Steels

Tables 3 to 9 inclusive of the SAE Handbook, pages 284 to 286, plus the NE (National Emergency) steels were completely revised by Division XIV – Alloy Steels. From the current Alloy lists one steel was deleted (3240) and 30 steels added. Changes in the NE steels added four numbers and deleted 44.

The prefix letter "A" which has denoted Open Hearth Steel has been dropped since the great majority of alloy steels are made by that process. Hence, all alloy steels without letter prefix are Open Hearth. AISI has also adopted this method of listing.

Chairman of Division XIV – Alloy Steels, is E. H. Stilwill, Chrysler Corp. Other members of the

TABLE 10—TRIPLE ALLOY STEELS (See Note 3)

SAE Number	Nominal Chemical Ranges								Corresp. AISI Number
	C	Mn	P	S	Si	Ni	Cr	Mo	
8615	0.13–0.18	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8615
8617	0.15–0.20	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8617
8620	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8620
8622	0.20–0.25	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8622
8625	0.23–0.28	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8625
8627	0.25–0.30	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8627
8630	0.28–0.33	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8630
8632	0.30–0.35	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8632
8635	0.33–0.38	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8635
8637	0.35–0.40	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8637
8640	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8640
8641	0.38–0.43	0.75–1.00	0.040	.040 max. / .060 min.	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8641
8642	0.40–0.45	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8642
8645	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8645
8647	0.45–0.50	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8647
8650	0.48–0.53	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8650
8653	0.50–0.56	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.50–0.80	0.15–0.25	8653
8655	0.50–0.60	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8655
8660	0.55–0.65	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.15–0.25	8660
8720	0.18–0.23	0.70–0.90	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30	8720
8735	0.33–0.38	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30	8735
8740	0.38–0.43	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30	8740
8745	0.43–0.48	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30	8745
8750	0.48–0.53	0.75–1.00	0.040	0.040	0.20–0.35	0.40–0.70	0.40–0.60	0.20–0.30	8750
9310[4]	0.08–0.13	0.45–0.65	0.025	0.025	0.20–0.35	3.00–3.50	1.00–1.40	0.08–0.15	E9310
9315[4]	0.13–0.18	0.45–0.65	0.025	0.025	0.20–0.35	3.00–3.50	1.00–1.40	0.08–0.15	E9315
9317[4]	0.15–0.20	0.45–0.65	0.025	0.025	0.20–0.35	3.00–3.50	1.00–1.40	0.08–0.15	E9317
9437	0.35–0.40	0.90–1.20	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15	9437
9440	0.38–0.43	0.90–1.20	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15	9440
9442	0.40–0.45	1.00–1.30	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15	9442
9445	0.43–0.48	1.00–1.30	0.040	0.040	0.20–0.35	0.30–0.60	0.30–0.50	0.08–0.15	9445
9747	0.45–0.50	0.50–0.80	0.040	0.040	0.20–0.35	0.40–0.70	0.10–0.25	0.15–0.25	9747
9763	0.60–0.67	0.50–0.80	0.040	0.040	0.20–0.35	0.40–0.70	0.10–0.25	0.15–0.25	9763
9840	0.38–0.43	0.70–0.90	0.040	0.040	0.20–0.35	0.85–1.15	0.70–0.90	0.20–0.30	9840
9845	0.43–0.48	0.70–0.90	0.040	0.040	0.20–0.35	0.85–1.15	0.70–0.90	0.20–0.30	9845
9850	0.48–0.53	0.70–0.90	0.040	0.040	0.20–0.35	0.85–1.15	0.70–0.90	0.20–0.30	9850

[4] Electric Furnace Steel

Where there is no prefix in AISI number the steel is predominately open hearth.

Division are: W. G. Bischoff, Steel & Tube Division, Timken Roller Bearing Co.; H. Bornstein, Deere & Co.; B. Clements, Wright Aeronautical Corp.; J. T. Jarman, Allis-Chalmers Mfg. Co.; E. O. Mann, Chevrolet Motor Division; D. C. McVey, International Harvester Co.; Dr. J. C. Mertz, Pratt & Whitney Aircraft Division; W. H. Naegely, J. I. Case Co.; G. C. Riegel, Caterpillar Tractor Co.; J. E. Spittle, Ford Motor Co.; E. T. Walton, Crucible Steel Co. of America; L. E. Webb, Frost Gear & Forge Division, Clark Equipment Co.; S. L. Widrig, Spicer Mfg. Corp.; P. R. Wray, Carnegie-Illinois Steel Corp.; and Henry Wysor, Bethlehem Steel Co.

Special alloy steels carried as company specifications by large users were carefully reviewed by the user and producer metallurgists of Division XIV and Panel C and D. Additions, deletions and revisions have been made by SAE and AISI so that the two lists are now in virtual agreement.

Table 3 – Manganese steels now appearing on page 284 of the 1947 Handbook will continue without change except for the deletion of prefix letter "A."

No changes were made in the five steels now listed in Table 4 – Nickel Steels other than dropping the "A" prefix in the AISI column. Two electric furnace steels, 2512 and 2517, have been added. Table 4 – Nickel Steels is included with this article.

Changes made in Table 5 – Nickel Chromium Steels, include the deletion of prefix letter "A," deletion of 3240, addition of electric furnace steel 3316. The revised table is included in this article.

Table 6 – Molybdenum Steels now appearing on

page 285 of the 1947 Handbook required four separate sections and two letter ballots of the ISTC to bring about an agreement among users and producers on those steels. There were no deletions and the following additions were made: 4017, 4024, 4028, 4053, 4317, 4608, 4617, X4620, 4621, 4812 and 4817. Changes in composition were made in 4037, 4042, 4047, 4068, and 4150.

Nine steels were added to Table 7 – Chromium Steels. They are 5045, 5046, 5115, 5130, 5132, 5135, 5145, 5147 and 5152. One steel (5150) was changed in composition.

The revised Table 7 is included with this article.

There is only one steel, 6150, in Table 8 – Chromium Vanadium Steel. No additions were made but the composition of 6150 is changed. Carbon is to be 0.48-0.53 and manganese 0.70-0.90.

NE (National Emergency) Steels Changed to SAE Steels

In view of the passing of the wartime emergency, members of the Iron and Steel Committee felt that there is no longer a reason to continue the listing of the steels now published on pages 278 and 279 of the 1947 SAE Handbook, under the caption "National Emergency Steel Compositions." Accordingly the lists were thoroughly reviewed with respect to their usage, the number of steels materially reduced, and the designations of those retained in the various classifications changed from "NE" to "SAE." The new tables will be placed in their proper numerical position with the other SAE tables.

One number (8612) was deleted and four numbers (8641, 8653, 8655 and 8660) added to the 8600 Series. From the 8700 Series list all but five numbers (8720, 8735, 8740, 8745, and 8750) were deleted.

All but four (9437, 9440, 9442 and 9445) of the 9400 Series have been deleted. Two (9747 and 9763) of the 9700 Series remain. 9840, 9845 and 9850 have been retained in the 9800 Series, while the entire 9900 Series has been deleted.

Four new steels (9254, 9255, 9261 and 9262) have been added to Table 9 – Silicon Manganese Steels on page 286 of the 1947 Handbook which is to be called Table 10 – Chromium-Silicon-Manganese Steels.

A new 9300 Series of three electric furnace steels has been created and added to the triple alloy series – 9310, 9315, and 9317.

The lists and compositions of the former NE steels retained as SAE steels together with the added 9200 and 9300 steels are included in this article.

HOW TO GET the revised SAE Iron & Steel Specifications

- These newly-revised SAE specifications on iron and steel chemical compositions are being made available in the familiar SAE Handbook format for those desiring them prior to their publication in the 1948 SAE Handbook.
- The SAE Special Publications Department is offering the tables for sale together with a reprint from the Handbook containing all SAE iron and steel standards and specifications.
- Price of the completely-packaged SAE Iron and Steel Standards and Specifications containing the new tables, SP-30, is $1.50 to members and $3.00 to nonmembers.

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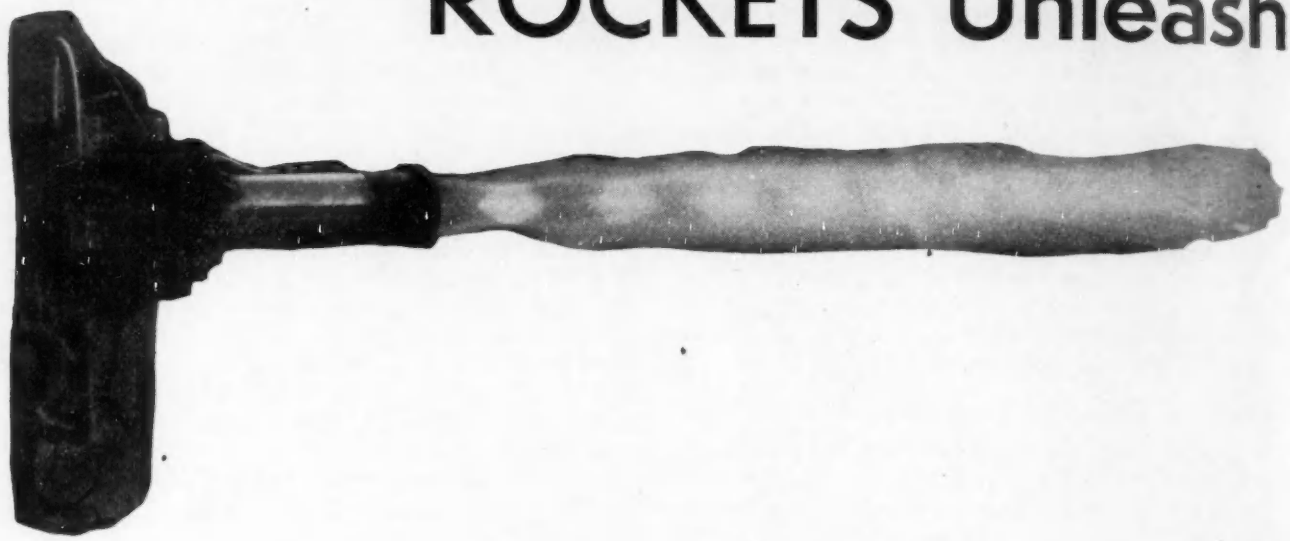

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One of the most interesting things about a rocket is how it gets its forward motion. A popular misconception has it that the hot gases coming from the nozzle of a rocket engine push against the air and produce the forward motion. Technical men insist that the forward motion can be explained by Newton's Third Law – "to every action there is an equal and opposite reaction."

Each particle of hot gas in a rocket engine, to propel itself through the nozzle, must rebound from the forward wall or from another particle. The accumulation of these small impulses against the forward wall pushes the engine forward with respect to the earth or the surrounding atmosphere. Therefore, push of the jet against the motor rather than push of the jet against the air moves jet devices forward. A rocket can fly through space only because it does not depend upon oxygen in the air for combustion, but carries its own supply with the fuel.

Theoretically a rocket engine can travel faster than the velocity of its jet, but the velocity of the gases with respect to the engine remains constant. In a vacuum the rocket will accelerate as long as the engine is in operation. In the atmosphere a speed will be reached where the drag due to air resistance equals the thrust and no further acceleration is possible.

Jet velocity, as a rocket term, is equal to the specific impulse times 32.2, the acceleration of gravity. For a specific impulse of 200, the jet velocity is approximately 6400 ft/sec. The specific impulse is equal to the pounds of thrust divided by the total pounds of propellant consumed per second. For a thrust of 240 lb and a propellant consumption of 1.2 lb/sec, the specific impulse is 200 sec.

Specific fuel consumption is the reciprocal of the specific impulse, or the pounds of propellant consumed per second per pound of thrust. Therefore, for a specific impulse of 200, the propellant consumption is 0.005 lb/sec per lb of thrust. A reciprocating engine man would say 9000 lb of fuel per hour for 100 hp at 75 mph. Rocket men, using 100 hp to travel at a speed of 7500 mph for the same distance, state a more favorable total propellant consumption of approximately 0.2 lb/hp.

It must be remembered that in rocket flight, power is only required during one-fifth of the total time traveled. During the remainder of the flight the rocket-powered unit will coast through space.

The figure arrived at compares quite favorably with the 0.3 lb/hp per hour that might result for the same distance in a light plane. In this case, it all depends on who figures the fuel consumption – a reciprocating engine man or a rocket man. Actually, at a certain speed which may be reached in the near future – say 2500 mph – it is possible to get the same mileage per gallon with a rocket engine as with a reciprocating engine at 350 mph.

* Paper "Rocket Engines as Applied to Future Aircraft Powerplants," was presented at SAE Williamsport Group, Feb. 3, 1947.

Revolution In Air Travel

BASED ON A PAPER* BY

ALFRED K. HUSE

Senior Project Engineer, Reaction Motors, Inc.

A rocket which carries its own supply of oxygen or oxidizer can be one of two basic types – controllable or uncontrollable, liquid propellant or solid propellant. The liquid propellant types are controllable in that thrust can be obtained when wanted – and in the desired amount. Liquid bipropellant combinations currently used are liquid oxygen – alcohol and acid-aniline.

For Safer Air Transport

For commercial airline use the rocket could make small fields accessible to large transports by decreasing both the aircraft's take-off and landing distances. Propelling the plane forward, JATO units in use today, see Fig. 1 – Reaction Motors, Inc. liquid-propellant JATO – augment engine power and require a fraction of the runway normally used for take-off.

By the same token a rocket could be operated in the opposite direction to brake the plane's forward motion and minimize runway length required for landing. Such an arrangement would be quite handy to the pilot flying a large four-engine transport that's in trouble, with only a small airfield or clearing available for landing.

Providing airliners and even military craft with auxiliary rocket power would avert common accidents that menace lives and property. Should the pilot taking off find himself racing toward the end of the runway and unable to take off for some reason, he could switch on his braking rocket unit and stop before plowing through an onrushing building or obstruction. And should one or two engines fail immediately after take-off, the added thrust from rockets could shoot the plane up to higher altitude, giving the pilot that much needed time and precious altitude to try to right the condition or come back for a landing.

Over mountainous areas rockets could shoot a plane over a mountain looming perilously close without sufficient time to bank away or fly over it. Side winds need be no hazard to take-off or schedule delay because rocket power could readily overcome any overturning tendencies.

Carrying a rocket installation need not penalize the airliner by displacing payload. Many current commercial aircraft are nose-heavy and carry 700 to 800 lb of useless ballast in the tail. An entire rocket installation need weigh no more than 200 lb and the propellants about 500 lb. In fact the rocket should increase payload-carrying ability since gross aircraft weight at take-off is limited by runway length. Rocket power will lift this limitation.

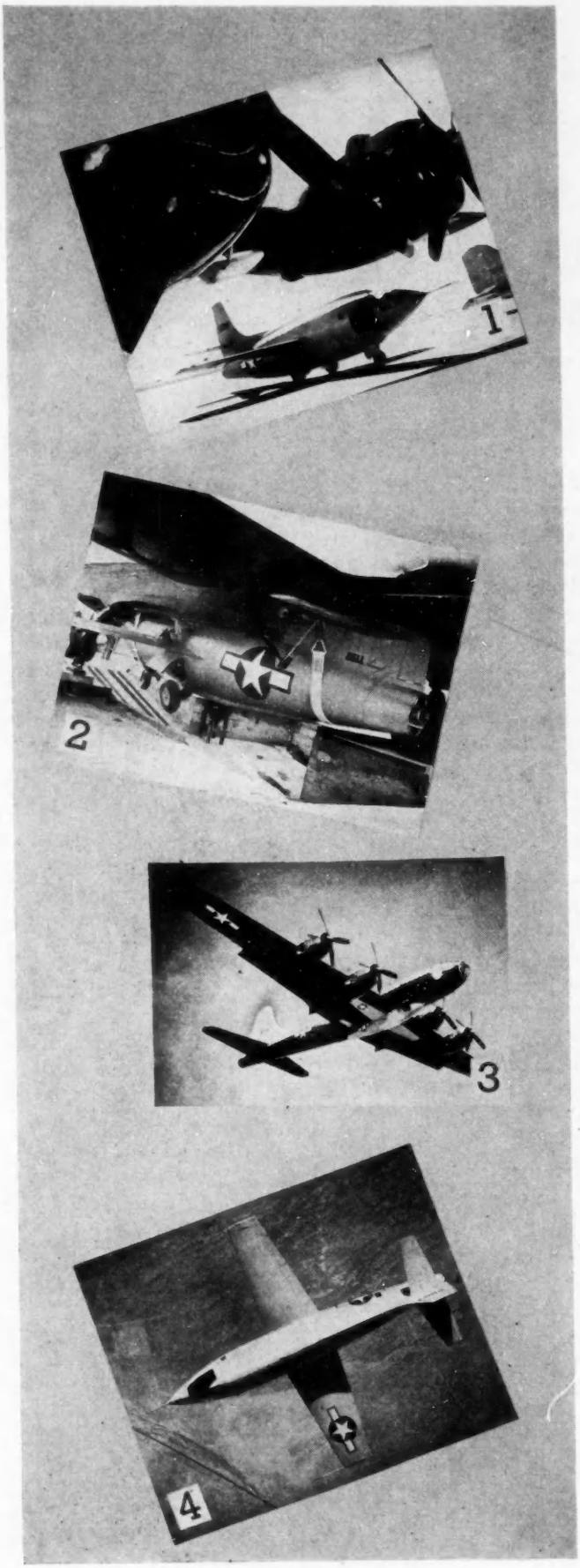
Currently on the Market

Devices that will perform all of these operations can be had today. It is possible to build a multi-rocket unit so that the thrust line of each rocket can be varied to give directional control. It is also possible to produce variable thrust units – to deliver as much thrust as desired whenever it's wanted. A liquid-propellant unit might be used several times during one flight.

Take, for example, a rocket installation delivering from 200 to 10,000 lb of thrust with 500 lb of propellant on an airliner with 8000 hp traveling at

In peace as in war the rocket will play an important role in aviation's future, Huse shows here. He cites some half dozen applications for rockets as auxiliary power which could spell the difference between a safe landing and a crack-up in commercial air travel today. For these uses rocket engines are now available.

In fact-backed crystal-ball gazing the author foresees passenger travel in 2500-mph rocket-powered space ships with little discomfort. He outlines some real problems engineers must overcome before achieving this goal. Trends in rocket fuels and the outlook for atomic-powered rockets are discussed as a part of this long-range picture.



First American

Bell's XS-1 pioneered flight by rocket-powered aircraft in this country. These pictures depict scenes from this epic-making flight.

Some comparison in size between this experimental supersonic aircraft and the B-29 carrier which will fly it to safe altitude for power test can be seen in (1). Mechanics in (2) are strapping the XS-1 to the B-29 and making last-minute preparations for take-off.

Hugging the belly of its carrier, the XS-1 is being carried aloft for the mid-air launching, (3). The frosting on the XS-1 fuselage at the location of the liquid oxygen tanks does not create additional drag; at the speed of this plane the heat of skin friction will melt the frosting.

Ship away! In (4) the XS-1 has just been released from its carrier at an altitude of 35,000 ft. This is a most crucial and dramatic moment.

375 mph. (At this speed 1 lb of thrust equals 1 hp.) If one engine fails and the pilot wishes to maintain that speed, he'll set his rocket for a 2000-lb thrust. This rate of thrust will consume 20 lb of propellant per sec, giving him 50 sec of 2000-lb thrust from the 500 lb of propellant.

Should the pilot desire only a 200-lb thrust, his rocket motor will deliver this boost for over 8 min. And whether its 200, 2000, or 10,000 lb of thrust that's needed, liquid-propellant units make it available in short bursts or for one shot.

Today rocket engines are available as off-the-shelf items with thrust ratings starting at 200 lb up to 1000 lb in 200-lb increments, and up to 10,000 lb in 1000-lb increments. Oxygen-alcohol or acid-aniline propellants may be used in these rockets.

Propellant handling need constitute no danger to ground crew personnel. It can be kept in cartridge-type tanks installed on the airplane by one quick disconnect. Empty tanks can be filled for re-use by the propellant supplier. This method should also make for safe and easy storage on an airfield.

Plane manufacturers can facilitate use of auxiliary rocket power for transport aircraft by providing a space in the tail for the rocket engine and tankage about 6 ft long and about 1½ ft in diameter. No structural reinforcing will be necessary to carry the installation. A small air scoop and two drain lines would be ample provision for ventilation and would solve the pump-sealing problem on an acid aniline pump.

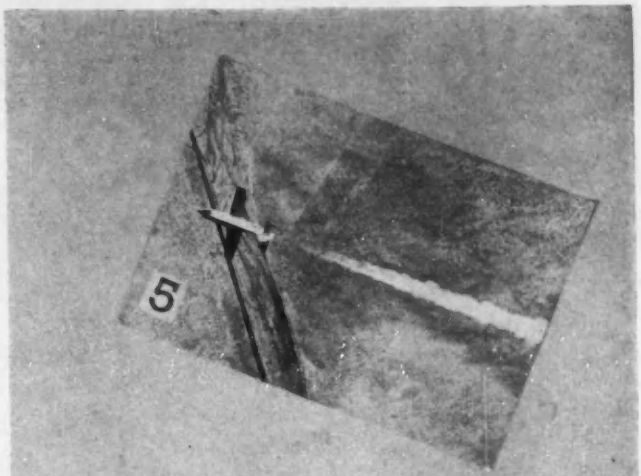
It would also be desirable for the airframe builder to provide one hydraulic control to vary direction of thrust and another to vary the amount of thrust. Starting and shut-down of rockets will be controlled by automatic equipment.

For large aircraft, the engine manufacturer will not have to make any special provisions. The rocket motor itself will drive a turbine pump with the exhaust gas or by a gas generator, eliminating

Rocket Flight

Success or failure of countless hours of design and research depend on whether the rocket engine will start and power this plane of the future. Test pilot Slick Godwin flicks the switch to start the first cylinder; oxygen and alcohol ignite; the aircraft zooms forward at a top speed of 550 mph on only one cylinder (5). After putting the plane through its paces under power, Godwin cuts the engine and glides in safely for a landing (6). He has made Dec. 9, 1946, an important date in aviation history.

The rocket engine that made this flight possible is the Reaction Motors Model 6000C4 – a four-cylinder, 6000-lb thrust unit, (7) and (8), that measures 18 in. in diameter and 56 in. in length. The installation weighs about 210 lb. Such multicylinder units are more flexible and easier to maintain than a single-cylinder rocket with the same thrust output.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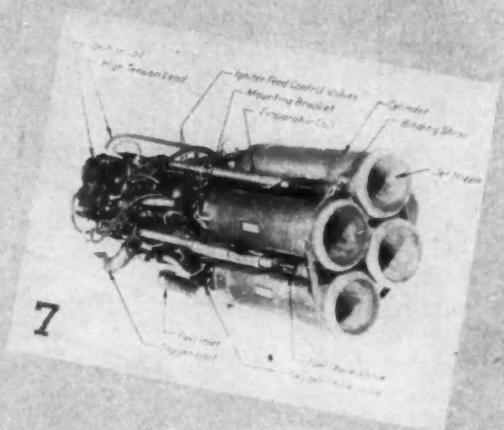
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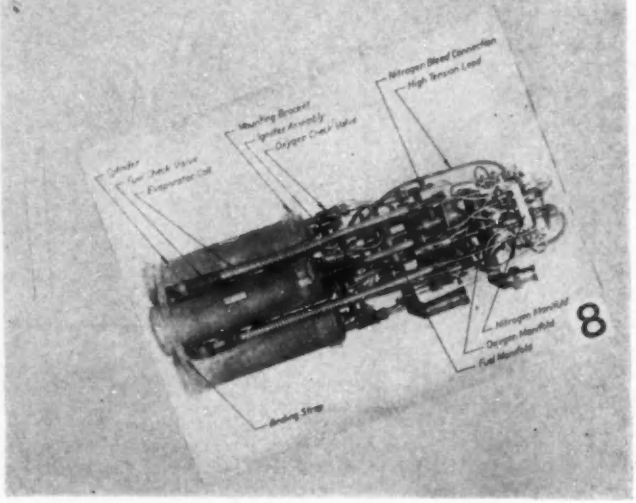
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the need for high-pressure tanks. For small planes, the engine maker should anticipate the need for an accessory pad for a small hydraulic motor to drive the rocket fuel and oxidizer pumps.

Future Flight

As an auxiliary power source the rocket might bridge the transsonic tempest for supersonic aircraft. A turbojet-powered plane could employ rockets for the extra burst of speed and power required to pierce the Mach 1 barrier and again for rapid deceleration to drop back to subsonic speeds.

Progress in rocketry should evolve in the not too-distant future a completely rocket-powered aircraft traveling from New York to London in less than 2 hr. One of the obstacles to this feat today is the lack of a suitable fuel. It all comes back to specific impulse – an indication of the energy available from the fuel.

Liquid oxygen-alcohol propellants have a specific impulse of 230. This represents roughly a 60% efficiency based on impulse. As shown in Fig. 2, a theoretical 100% efficiency would make possible a much higher specific impulse. But factors such as nozzle efficiency and other parasites make this impossible. In fact expansion ratios several times what they are today are needed to achieve higher efficiencies from the total energy available in the liquid propellant. But a 90% efficiency with these propellants is foreseen for the near future.

Acid aniline has a specific impulse of only 200, but has certain attractive characteristics. This propellant combination ignites spontaneously whereas the liquid oxygen-alcohol requires an igniter to start combustion.

What about atomic energy or fissionable products for rocket fuel? Little is known of the equivalent specific impulse of atomic energy, guesses varying from 400 to 2000. And it will require an entirely different rocket configuration. The energy release will heat a gas that will provide forward motion upon being exhausted.

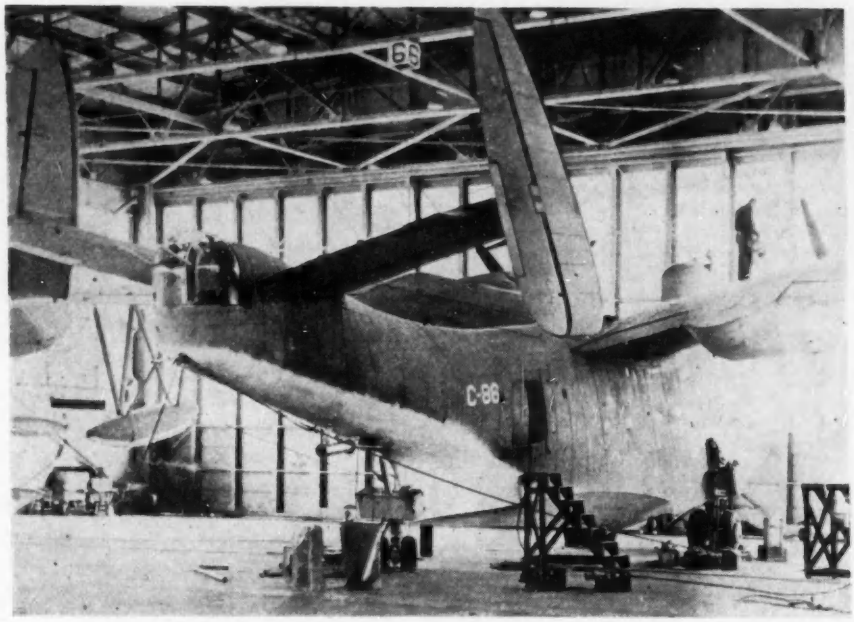


Fig. 1 – With a liquid-propellant JATO unit, shown just behind the hull step, this Martin PBY, weighing 55,000 lb, took off in 33 sec. Its take-off time at this gross load without JATO is 62.5 sec.

Applying atomic energy to rockets takes talk of missiles-to-the-moon out of the Buck Rogers area and places it into the realm of practicability. Moon-bound missiles using such high-energy fuels need not be much larger than the V-2.

Passenger travel in 2500-mph airplanes is possible since accelerations will not exceed 1 g. Rockets will travel by trajectory, shooting up to a high altitude and gliding most of the way to their destination. Transatlantic missiles are possible today. At the end of the war the Germans had designed a V-2 rocket with a booster capable of bombing New York from European launching sites.

Major obstacle to passenger-carrying rockets is the lack of a method to land them.

Rockets merit much research and development because of their simplicity and the frontiers they will push back for aviation. Durability of the engine is unlimited since it has no moving parts. After more than three months of operation, several rockets were examined and almost no signs of wear found. Although the propellants burn at temperatures of 5000 to 5500 F, a coolant in the regenerative motor circulates around the nozzles and prevents them from burning out.

And for the same thrust the rocket engine is lighter and much more compact than a pulse or ram jet. It carries its own oxygen and can travel in space; but the ram jet needs oxygen from the atmosphere to operate and is more efficient at supersonic speeds. These factors limit its use. The pulse jet also must extract oxygen from the atmosphere; but its efficiency is good at normal speeds in the subsonic range.

In addition to powering aircraft and guided missiles, the rocket will serve scientists and engineers as a flying laboratory, with test data telemetered back to ground recording devices. Weather forecasters may also learn to use the rocket to uncover information not now available.

Uses from the practical to the fantastic are being found for rocket power. Given the time, facilities, and support, research and development will harness rockets and open many new vistas in engineering.

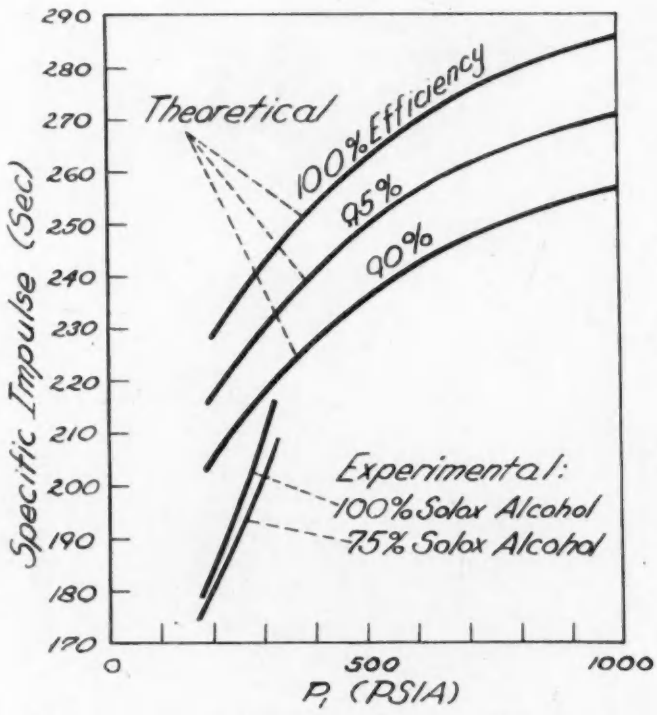


Fig. 2 – Higher specific impulses from liquid oxygen-alcohol propellants will be attained by closing the gap between practical and theoretical values. More efficient rocket installations are the means to this end

FARM POWER GAINS

AS AMERICA'S tractor industry launches itself into the small farm market, engineers are hard at work providing tractors with more rider comfort, ease of operation, and higher speeds – and petroleum technologists are working with them toward improved economy. These disclosures highlighted the SAE National Tractor Meeting which brought some 600 members and guests to the Hotel Schroeder in Milwaukee.

The current attack on the small farm market is being made with units like the 10½ hp riding tractor described at the meeting as designed for the 3,000,000-odd truck farmers, orchardists, market gardeners and gentlemen-farmers who do not need or cannot afford a full-scale tractor.

Typical of the new small tractor designs are high rubber-tired wheels, power takeoff for operating the moving components of implements, short turning radii, and good visibility.

The engineering work on all sizes of tractors is moving toward improvement of features with which farmers have expressed dissatisfaction. Hard riding, hard steering, poor visibility, bothersome exhaust gases and engine noises, and difficult-operating implements are prominent among features which need engineering attention, according to a survey reported at the meeting.

Hard Riding and Fatigue

Hard riding and seat-discomfort seem likely to top the engineer's list of problems to be attacked, because 12% of the farmers interviewed turned out to have replaced the original seats with contrivances of their own ingenuity. It was generally agreed that hard riding reduces overall tillage and harvesting jobs because roughness induces excessive fatigue and slows reaction time of the operator.

Farmers exert too much physical energy in tractor operation, and it is indicated that fatigue is an important cause of accidents, as has been shown in truck, bus and car driving, and in other occupational hazard studies. One speaker said that the industry is in the midst of a revolution involving reduction of effort required to attach, control and detach implements. Farmers are already cautious in selecting tools which are quickly and easily attached and controlled and he predicts they will become increasingly critical.

Constant attention required and the vibration of tractor mowers is tiring, for example. Plowing is difficult because the farmer looks alternately in directions almost 180 deg from ahead for steering, and backward to watch the plowing. Combines, corn pickers, and hay balers require so much constant attention that they are fatiguing to operate, it was pointed out.

Despite the fact that most farmers, according to

● Members of the General Committee for the meeting included: (left to right) E. E. Bryant, G. D. Sickert, George W. Curtis, and W. F. Strehlow. Chairman was C. T. O'Harrow (see p. 31)

this survey, seem satisfied with the brake and clutch pedal pressures, engineers seemed to be agreed that 15 to 20 lb pressures are best, although 15 years ago they were 70 lb and over, and many are still as high as 50 lb.

Speed Is Compromise

Emphasis was put on the question of tractor speeds by many at the meeting. It was agreed that the best compromise is the highest speed at which the particular implement can work. Tractors came first, it was pointed out. They were simply hitched to conventional horse drawn implements.

But in recent years considerable coordination between tractor and implement manufacturers has brought improved tillage and harvesting equipment capable of working at higher speeds. The small acreage farmer usually demands a wide range of operations from his tractor, at speeds of from 1½ mph with a rotary hoe the first time over, to 10 mph with the same implement, providing the farmer can control his machinery and take the punishment, one paper disclosed.

Speeds, another speaker pointed out, are generally limited by the operator's skill in controlling the equipment and his ability to do this despite a rough ride.

Today's tractors average speeds of 2 2/3 in first, 3 3/4 in second, 5 in third, and a road speed of nearly 10 mph in high gear. In winter, and for exceedingly difficult work, one of the speakers recommended serious consideration of a low of 1½ mph in addition to cover what he thinks is the whole range of farm implement operations.

Pneumatic tires and a standardized power takeoff at the draw bar are concepts that have changed the entire course of American agriculture. The modern tractor has four forward speeds in the range of about 2 to 10 mph, and the take off has been standardized at 535 rpm.

Because the reaction speed of the farmer, as of all human beings, is controlled by nature, advent of more general use of automatic or pushbutton controls seems probable.

Ease of Operation

An important aid to ease of operation visualized by one engineer would be a separate clutch to stop the forward travel of the tractor but maintain live power takeoff when the straw being harvested by a combine became exceedingly tough or when stones had been blown into and emmeshed with the vegetation.

Although it appears that this improvement would be most advantageous when operating forage harvesters, it would be valuable in speeding up all implement use because by proper selection and shifting his gears on the fly the farmer could work at the highest possible speed uphill or downhill, through heavy or light growth and on dry fast land or in soft earth without stopping.

Standardization of capacities of power controlled implements was urged by another speaker, who cited progress made by a joint SAE – American Society of Agricultural Engineers Committee on dimensional standardization of the cylinder and its location on the tractor. Capacity standards are important, he said, because they would open the way for interchangeability of implements with any tractor in a given drawbar horsepower range.

Advent of LP-Gas Fuels

Liquefied petroleum gases have shown a large increase in areas where bulk handling of propane and butane is available, the meeting was told. With advantageous antiknock characteristics, this type of fuel permits lower specific fuel consumption, crankcase dilution is absent, and carbon formation is substantially reduced.

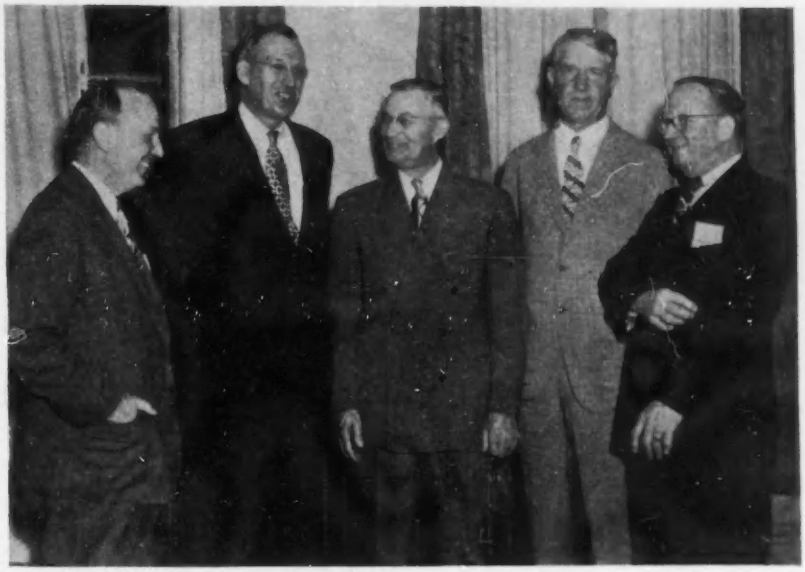
These fuels are of particular interest in connection with development work now going on in the field of pressure injection because they are so readily vaporized. Little carbon is deposited, indicating less trouble with nozzle clogging than with other types of fuel.

Cold intake manifolds are recommended for gas fuels to obtain highest volumetric efficiency, but this is not essential. The heat box can be removed from the manifold, and shields can be installed to retard heat radiation from nearby exhaust piping. A carburetor air intake can be readily rigged up

Based on first hand reports of discussions and papers presented at the SAE National Tractor Meeting, Sept. 17-18, Milwaukee, at four technical sessions, two luncheons, and dinner. Chairmen of technical sessions were C. G. A. Rosen, Martin Ronning, L. A. Gilmer, and L. S. Pfost. B. G. Van Zee was dinner chairman, E. M. Schultheis was toastmaster, and President C. E. Frudden and John Strohm, associate editor of "Country Gentleman", were dinner speakers.

●

Papers were: "Butane and Propane as Tractor Fuels," by E. A. Jamison, W. F. Swett, J. R. Strother, and C. R. Dougherty, Phillips Petroleum Co.; "The Elimination of Combustion Knock," by E. M. Barber, Texas Co.; "Tillage and Planting," by H. V. Hansen, J. I. Case Co.; "Harvesting Grain, Hay, and Corn," by Robert Worrell, Allis-Chalmers Mfg. Co.; "Capacity Requirements for Power Control," by Stanley Madill and Knud Sorensen, John Deere Tractor Co.; "Stationary Axle and Rotating Axle Idler Wheel Mountings Compared for Implement and Tractor Service," by George Curtis, Timken Roller Bearing Co.; "Maintenance Engineer's View of the Tractor Service Business," by Paul Dumas, Implement & Tractor Magazine; "A Practical Approach to Operator's Comfort," by C. W. Cannon and Earl Cox, Allis-Chalmers Mfg. Co., and "Farmall Cub Tractor and Implements," by C. A. Hubert and J. L. Hipple, International Harvester Co.



● Among the manufacturing executives who were honored guests at the dinner were: (left to right) Frank R. Pierce, president of Dearborn Motors Corp.; J. M. Tucker, vice-president of Massey-Harris Co.; A. W. Van Hercke, director of engineering, Tractor Division, Allis-Chalmers Mfg. Co.; L. H. Clausen, president, J. I. Case Co., and A. W. Phelps, president of the Oliver Corp.

● Vice-President B. G. Van Zee (left) with C. T. O'Harrow, chairman of the General Committee and chairman of the Tractor Activity Meetings Committee

to improve the cooling for higher efficiency.

A hypothesis offered by one speaker was that LP-gas might be introduced by pressure injection. Although such a device had not been put to test to the speaker's knowledge, he thought advantageous results might be accomplished in this way.

Despite the advantages of propane and butane fuels, discussers brought out that to obtain optimum economy and smoothness of operation an engine designed for these liquefied petroleum gases would look like a plumber's nightmare with a multitude of valves and fittings.

A 250 hp engine designed for these fuels would cost about 40% more than conventional gasoline engines, one engineer estimated, while another put the higher cost of such engines at $75.00 above conventional powerplants plus storage tank costs of not less than $175.00. However, the discussers agreed that the LP-gas engine was an intriguing idea, and one which might well be developed if the economics of fuel supply, including state regulations of its use, worked out in favor of propane and butane.

Another discusser proposed injection with added heat, because part of the favorable behavior of these gases is at a pressure in excess of the critical pressure and a temperature above the critical temperature so the fuel would be a gas when injected.

Thus, he said, perfect atomization would be effected, smoke would be avoided even when the mixture was rich, carbon formation and oil contamination would be avoided by eliminating crackable droplets which could penetrate the gaseous boundary layer on the cylinder surface.

COMBAT VEHICLES Ride

BASED ON A PAPER* BY

Col. Joseph M. Colby

Detroit Arsenal, U. S. Army Ordnance

(This paper will be published in full in SAE Quarterly Transactions)

ENGINEERING progress has placed the onus for success of military vehicles on the suspension. The military has hitched its suspension designs to the torsion bar because the great shock-absorbing capacity makes this construction particularly suitable to combat operations.

With modern internal combustion engines, horsepower no longer limits mobility over battlefield terrain. It's the suspension that restricts speed since this mechanism irons out ground irregularities, reducing to a minimum shock transmitted to personnel and equipment in the hull.

The suspension also determines the following vehicle characteristics:

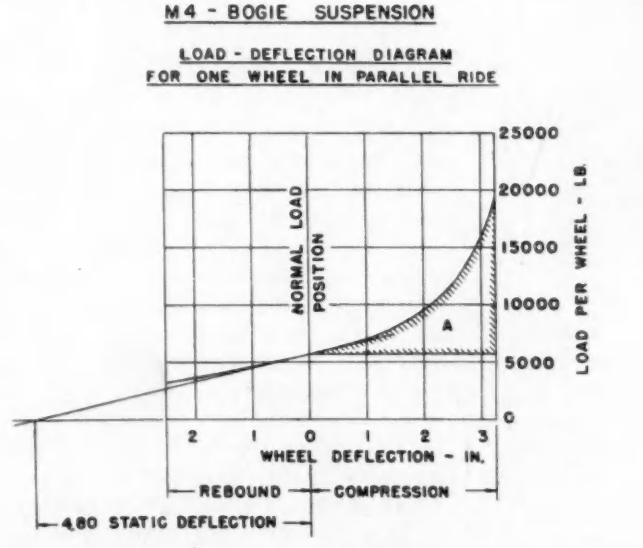


Fig. 1 – Spring curve for the volute-spring bogie suspension on the M4 medium tank. Small vertical wheel travel permitted by this suspension limits it to low-speed vehicles

1. Comfort and safety of the crew. It establishes the limit of their endurance.

2. Reliability of other tank components in proportion to its ability to absorb shock which otherwise might be transmitted to these parts.

3. Stability of the firing platform. Amplitude and frequency of vehicle pitch and roll affect the gunner's ability to deliver effective firepower, whether or not the gun is stabilized.

4. Obstacle-crossing ability. A suspension providing greater vertical movement of wheels will enable the vehicle to negotiate higher and more abrupt obstacles.

5. Tractive ability. A suspension which permits the track to conform to irregular terrain features allows more effective grouser action. Result: increased tractive ability.

Tosion Bar Boosts Performance

Military experts attach such great importance to the torsion bar suspension because it satisfies these criteria by offering:

a. Higher sustained speed over adverse battlefield conditions;

b. Greater comfort and reduced fatigue of tank personnel;

c. A more reliable vehicle since components are cushioned from shock;

d. A more stable firing platform for delivery of effective firepower;

e. Improved obstacle-crossing ability;

f. Better traction;

g. More reliable track operation through use of the compensator;

h. Greater protection since most of the mechanism is behind armor plate.

* Paper "Torsion Bar Suspension," was presented at SAE National Transportation Meeting, Chicago, April 17, 1947.

Better with TORSION BAR SUSPENSION

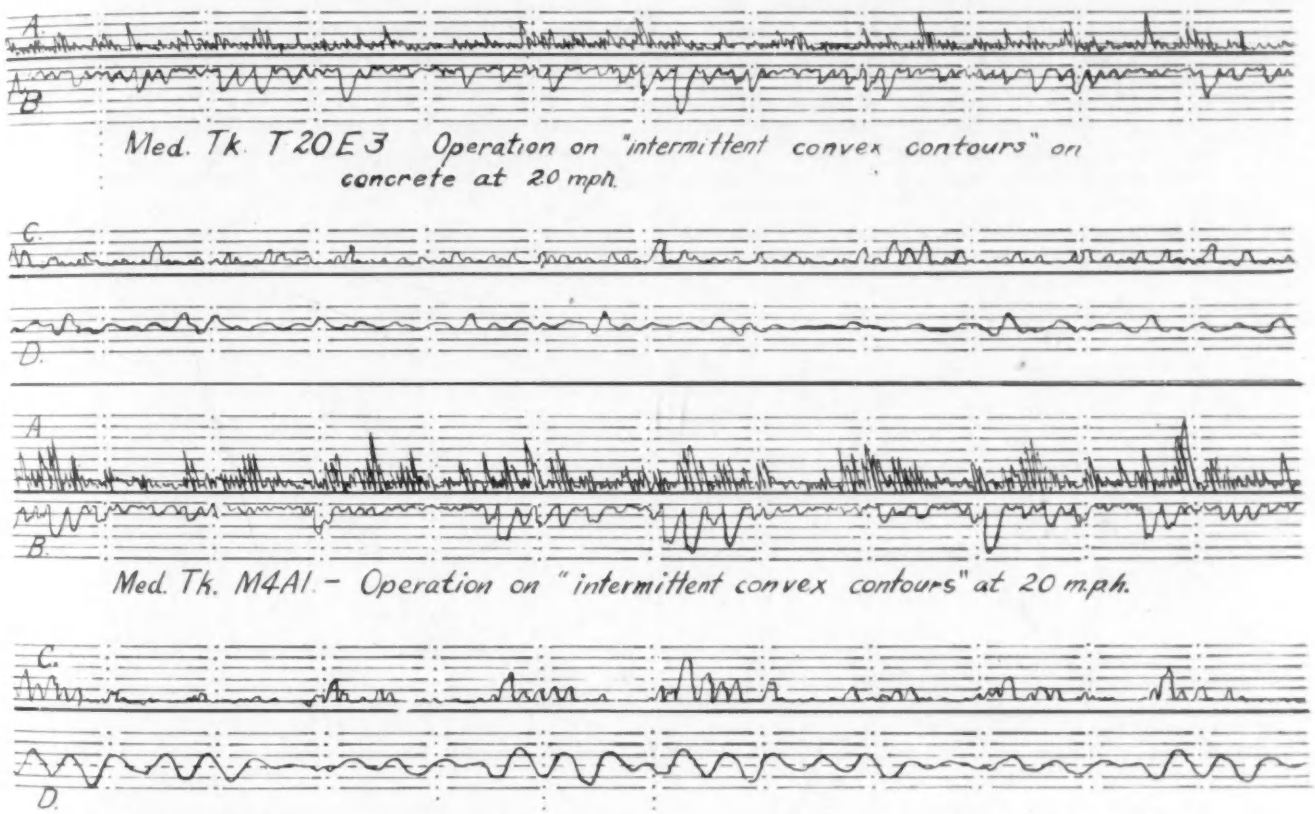


Fig. 2 – These data are results of tests comparing ride of the T20E3 tank, with torsion bar suspension, versus that of the M4A1 tank, with bogie-type suspension. Curve A represents vertical acceleration at the center of the fighting compartment; curve B is vertical acceleration at the right side of the hull; curve C is the vertical acceleration at the left side of the hull; curve D indicates pitching of the vehicle about a transverse axis

The torsion bar suspension accomplishes all this without increasing the critical width dimension of the vehicle.

While its predecessor – the volute-spring bogie suspension – was simple and reliable, it proved to be inadequate for modern equipment because it was intended for speeds below 10 mph. Its articulation or walking-beam action limits the wheel to a small vertical rise. The effect of articulation is lost at higher speeds so that the entire bogie pancakes to the ground, leaving only limited spring action to absorb the shock.

Spring curve for a wheel of a medium tank bogie is shown in Fig. 1. Vertical travel is 3¼ in. against a maximum compressive spring stress of 20,000 lb. Area "A" under the curve represents the shock-

absorbing capacity of this suspension. Obviously great improvement in ride could be made if the wheel travel against the spring could be increased.

Substituting an individually-sprung wheel for the bogie-type suspension solved the problem by providing the maximum wheel travel. But such early suspensions were criticized because they took 10 to 14 in. of inside hull width on each vehicle and width is the most critical combat vehicle dimension.

The torsion bar suspension overcomes this objection since it occupies no inside tank width. Vertical movement of the bogie wheel is transmitted through a crank arm to a shaft running transversely under or through the belly of the vehicle. Since the crank arm is rigidly attached at its ends both to bogie wheel axle and shaft, and since the shaft turns freely in a bearing at the crank end while the opposite end is anchored to the vehicle, vertical movement of the wheel twists the shaft.

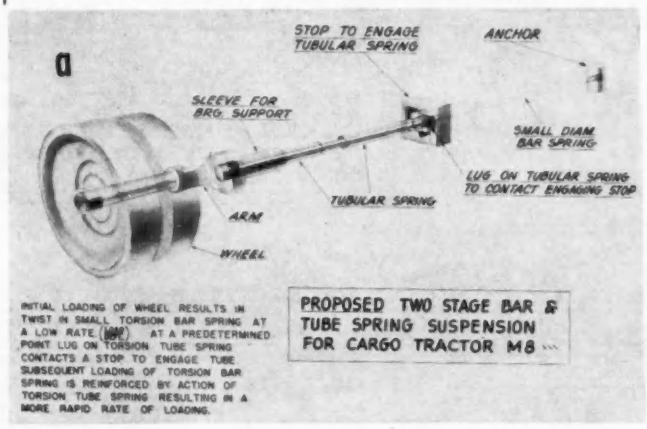
The transverse shaft is simply a rod-spring designed to resist the torque or twisting moment of the applied force; it then untwists and returns all components to normal position.

Early development tests demonstrated the greatly superior ride of the experimental medium tank T20E3 (with torsion bar suspension) over that of the medium tank M4A1. Fig. 2 summarizes

NEW MILITARY VEHICLE TORSION BAR DESIGNS

Since most combat vehicles such as tanks and armored cars are relatively constant-weight units, the difficult variable-load factor need not be considered in these designs. But with cargo-carrying tactical vehicles, effects of load on ride, weight on spring frequency, and impact on shock-absorbing capacity complicate the problem and resulting suspensions.

Present approach to the problem is the use of primary and secondary springing, as shown in "a," "b," and "d." The chart in "c" compares the secondary springing arrangement shown in "a" and "b". It shows the bar and tube torsion spring to give greater wheel deflection than the two-stage bar torsion spring suspension.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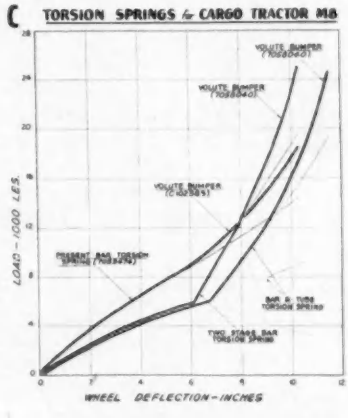
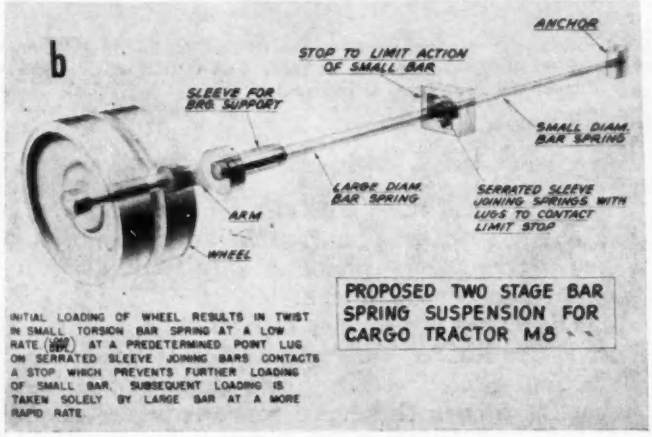
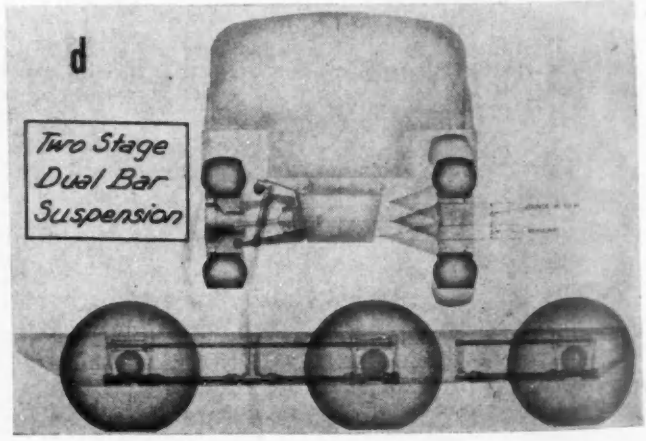
STOP TO ENGAGE TUBULAR SPRING
ANCHOR
SLEEVE FOR BRG. SUPPORT
SMALL DIAM. BAR SPRING
LUG ON TUBULAR SPRING TO CONTACT ENGAGING STOP
TUBULAR SPRING
ARM
WHEEL
INITIAL LOADING OF WHEEL RESULTS IN TWIST IN SMALL TORSION BAR SPRING AT A LOW RATE (RATE) AT A PREDETERMINED POINT LUG ON TORSION TUBE SPRING CONTACTS A STOP TO ENGAGE TUBE SUBSEQUENT LOADING OF TORSION BAR SPRING IS REINFORCED BY ACTION OF TORSION TUBE SPRING RESULTING IN A MORE RAPID RATE OF LOADING.
PROPOSED TWO STAGE BAR & TUBE SPRING SUSPENSION FOR CARGO TRACTOR M8




b
ANCHOR
STOP TO LIMIT ACTION OF SMALL BAR
SLEEVE FOR BRG. SUPPORT
SMALL DIAM. BAR SPRING
LARGE DIAM. BAR SPRING
SERRATED SLEEVE JOINING SPRINGS WITH LUGS TO CONTACT LIMIT STOP
ARM
WHEEL
INITIAL LOADING OF WHEEL RESULTS IN TWIST IN SMALL TORSION BAR SPRING AT A LOW RATE (RATE) AT A PREDETERMINED POINT LUG ON SERRATED SLEEVE JOINING BARS CONTACTS A STOP WHICH PREVENTS FURTHER LOADING OF SMALL BAR. SUBSEQUENT LOADING IS TAKEN SOLELY BY LARGE BAR AT A MORE RAPID RATE.
PROPOSED TWO STAGE BAR SPRING SUSPENSION FOR CARGO TRACTOR M8



the test results.

This and other initial designs achieved the functional objectives of torsion bar suspension. Growing in popularity, the torsion bar was then applied to light tank M24 and its associated combat team vehicles – dual 40mm gun motor carriage M19, 155mm howitzer motor carriage M41, 105mm howitzer motor carriage M37, and others.

Load-deflection of the torsion bar suspension in the medium tank M26 is shown in Fig. 3. Here each wheel has a maximum vertical movement of 8 in. from static load position to slam. Area "A" under the torsion bar spring curve reveals that this individually-sprung torsion bar has 4.2 times the shock-absorbing capacity of the volute-spring bogie suspension of the medium tank M4, shown in Fig. 1.

Absorbing the Shock

To increase further the shock-absorbing capacity of the torsion bar suspension, a volute-spring bumper comes into action after approximately 5½ in. of vertical wheel movement. Shock-absorbing capacity of the bumper spring, as indicated by area "C," is 1.5 times that of the M4 bogie suspension spring.

In addition to the volute-spring bumper, double-acting shock absorbers are placed on the two fore and aft wheels of the suspension. These shock absorbers not only damp out high-amplitude pitch tendency of this suspension, they also can absorb the energy within the shaded area "B" – a capacity more than three times that of the M4 bogie suspension.

Why the Ride Is Soft

Over good terrain where wheel travel is low, a soft ride is obtained because of the low rate of the torsion bar springs. Rougher terrain increases wheel-movement amplitude and brings the double-acting shock absorbers into play. This boosts the system's shock-absorbing capacity to a maximum that is nine times that of the M4 bogie suspension. Reverse action of the shock absorber absorbs much of the rebound force.

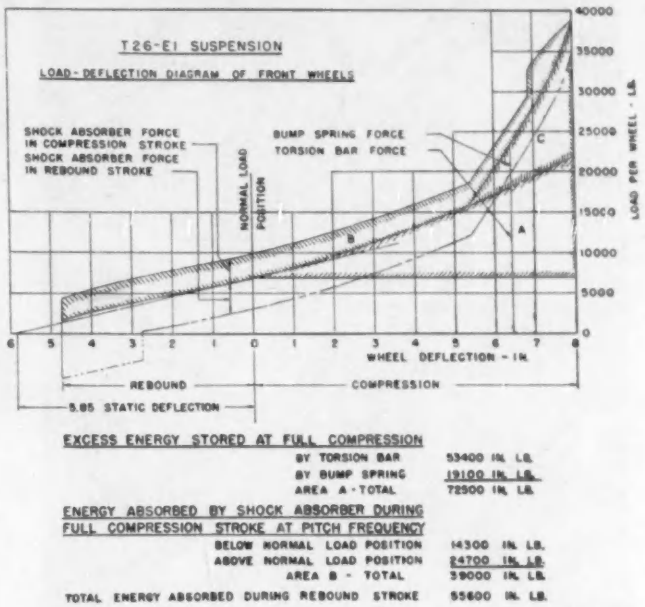
Another interesting mechanism in this new suspension is the track-slack compensator. With high-amplitude movement of the road wheels, the track tends to become slack when either the fore or aft wheel is fully raised. This tendency is overcome by providing linkages between the front wheels and sprockets and between rear wheels and idlers. The idler or sprocket moves out to adjust for track slack when the fore or aft wheel is raised.

Extensive tests demonstrated that compensators on one end of the vehicle will suffice.

Other desirable features of the torsion bar suspension include protection of the mechanism behind armor plate and reduction of unsprung weight. The faster the vehicle, the more important becomes the unsprung weight consideration.

These items explain why Army Ordnance feels the torsion bar is here to stay.

The Germans and Russians use torsion bar suspensions; but none of their known designs permits a large vertical wheel movement. Therefore, ride quality of their vehicles is considerably below American Ordnance standards.



EXCESS ENERGY STORED AT FULL COMPRESSION

BY TORSION BAR	53400 IN. LB.
BY BUMP SPRING	19100 IN. LB.
AREA A - TOTAL	72900 IN. LB.

ENERGY ABSORBED BY SHOCK ABSORBER DURING FULL COMPRESSION STROKE AT PITCH FREQUENCY

BELOW NORMAL LOAD POSITION	14300 IN. LB.
ABOVE NORMAL LOAD POSITION	24700 IN. LB.
AREA B - TOTAL	39000 IN. LB.
TOTAL ENERGY ABSORBED DURING REBOUND STROKE	55600 IN. LB.

Fig. 3 – These spring curves for the torsion-bar suspended M26 tank depict the superior shock-absorbing ability of this suspension compared with that of the volute-spring bogie type shown in Fig. 1

SAE DEVELOPS NEW TORSION BAR MANUAL

A first-of-its-kind manual on design and manufacture of torsion bar springs has been developed and readied for publication by an SAE committee of suspension specialists.

Prepared by this group under Tore Franzen, Chrysler Corp., the manual contains best-known practices that met with much success in the Army Ordnance wartime program . . . tools for the designer such as formulas, charts and sample calculations as well as proper production processing procedures.

The Manual on Design and Manufacture of Torsion Bar Springs is available from the SAE Special Publications Department. Price is $1.50 to members and $3.00 to nonmembers.

R. F. Gagg, left, a member of the Manly Memorial Medal Board of Award, presenting the 1946 Manly Medal to Cearcy D. Miller, Battelle Memorial Institute, for his paper "The Roles of Detonation Waves and Autoignition in Spark-Ignition Engine Knock as Shown by Photographs Taken at 40,000 and 200,000 Frames per Second," presented June 5, 1946, at the SAE Summer Meeting, and repeated before a number of SAE Sections. Miller was with the National Advisory Committee for Aeronautics when he made the study

Animated S

MARKED by animated discussion of a program of excellent papers, the SAE National Aeronautic Meeting, Oct. 2 to 4 in Los Angeles, was one of the highlights of this year's national technical meetings of the Society. . . . . .

The meeting was sponsored by the SAE Aircraft, Aircraft Powerplant, and Air Transport Activities with the cooperation of the San Diego, So. California, No. California, Oregon, and Northwest Sections, and the Spokane, Salt Lake City, and British Columbia Groups of the Society. The Aircraft Industries Association of America, Inc., and the Air Transport Association of America were cooperating organizations....

General Chairman was F. W. Fink, and J. H. Kindelberger again served as chairman of the Aircraft Engineering Display Committee.

Sonic Speeds Spur Aero Redesigning

AIRCRAFT engineers – irrevocably committed to provide flight at ever-increasing speeds – are discovering that as these speeds get closer and closer to the speed of sound the whole basic concept of aeronautical engineering must be revised. But this isn't all the meeting disclosed, for it was revealed that even when the design problems are solved, there will still remain operation and traffic problems of so critical a nature as to require a completely new approach before jet aircraft can be used in large numbers. The general aspects of both problems were discussed thoroughly at the sessions.

Not neglected, however, were the difficulties now facing the makers and operators of today's conventional transports, where ever higher speed (although still considerably under the speed of sound), longer range, and more nearly all-weather operations are providing plenty of headaches.

High-Speed Operation

Sweptback and low-aspect-ratio wings were suggested by one speaker for flight at transonic speeds (speeds around the speed of sound).

Although so far we do not have an adequate theory for the flow of gases in the transonic region, tests seem to indicate that sweep has somewhat the effect of raising the Mach number at which transonic disturbances occur and also of mitigating them when they finally are encountered, as speed increases still further.

The speaker explained that as airflow approaches the speed of sound, compressibility effects, due to the elasticity of air, cause pressure disturbances

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to be propagated. Drag increases so much, according to the speaker, that enormous power may be required. Far more serious, it was reported, are the problems of stability and control. Conventional airfoils apparently experience a sudden loss in lift as this region is entered, so that the problem is really one of evolving airfoil shapes that do not experience this loss in lift.

Before jet aircraft can be developed to a state of common usage, the all-weather, all-plane traffic control of high-speed flight must be adequately solved, according to another speaker.

The efficiency of the jet engine drops off as flight takes place at altitudes lower than the optimum, it seems, consequently it is important that the flight control system take into consideration what this altitude is for each plane. Apparently, planes must also be suitably spaced, as the high speeds of these craft require sufficient maneuvering airspace.

Probably most important of all, it was pointed out, the control system must be able to assign irrevocable landing positions and procedures before the plane is scheduled to begin its descent, and holding procedures should be eliminated as an integral part of the traffic system. Present-day holding and stacking procedures are both uneconomical and extremely unsafe for these aircraft, according to the speaker, who said flatly that if holding and stacking procedures are not eliminated, the jet transport certainly will be.

Although it was generally agreed that the metal fuel tank is on the way out, due to its weight and relatively small fuel capacity, considerable discussion arose as to the relative advantages of the two types of integral tanks.

The integral fuel tank utilizes structural cavi-

R. C. Loomis, Air Transport Meetings Committee chairman, left, with Major A. L. Klein, center, Aircraft Meetings Chairman, and L. D. Bonham, chairman of the SAE Southern California Section.

Based on discussions and nine papers presented at five Aircraft and Transport Sessions under chairmanship of **L. D. Bonham, H. W. Adams, J. S. Marriott, Mac Short** and **Harold Hoekstra**. . . . "Fuel Tanks – Integral versus Bladders versus Metal Cells," by **J. E. Lindberg, Jr., Frank Zerelli,** and **C. R. Ursell,** Pan American Airways, Inc.; "Research on Aircraft Hydraulic Packings," by **T. J. McCuistion, F. E. Clark, R. A. Clark,** and **L. E. Cheyney,** Battelle Memorial Institute; "The Cause for Pneumatics for Intermittent Services on Aircraft," by **H. F. Schmidt** and **H. F. Gerwig,** Consolidated Vultee Aircraft Corp.; "Traffic Control Requirements for Jet Transport Aircraft," by **W. T. Dickinson,** Douglas Aircraft Co., Inc.; "The Calculation of Heat Required for Thermal Ice-Prevention in Specified Icing Conditions," by **Carr Neel,** NACA; "Problems in Compressible Flows for Airplanes," by **John Stack,** NACA; "The Designer and Manufacturing Costs," by **G. W. Papen,** Lockheed Aircraft Corp.; "Decimal Dimensioning – What Profit?" by **O. E. Kirchner,** American Airlines, Inc.; and "A New Approach to Cockpit Layout," by **Com. T. D. Davies,** Bureau of Aeronautics, Navy Department. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

Presented at an Air Transport Session closed to reporting were three papers . . . Operational Experiences on the Constellation: "Structures, Engines and Accessories," by **J. G. Borger** and **A. P. Elebash,** Pan American Airways, Inc.; "Supercharging, Handling and Loading Characteristics," by **R. C. Loomis, E. E. Cannady** and **W. L. Harper,** Trans World Airline; Operational Experiences on the DC-6: "Supercharging, Handling and Loading Characteristics," by **J. S. Martin,** United Air Lines, Inc.

ties, generally in the wing, which are made fuel-tight by caulking with sealant between the faying surfaces of the structure surrounding the fuel cell, or by putting an adhesive covering over the interior of the structure.

The caulked type was reported to give excellent service; but, as one discusser pointed out, it requires a heavier structure, and extra rivets must be added to prevent motion between members.

The adhesive membrane type of tank, on the other hand, was said to be lighter and not to require the extra rivets. In some cases, however, poor service experience was reported with this type. It was admitted that it requires close fits between structural members and good accessibility must be provided for application of the material to the structure.

It appears that as experience with this type is being accumulated, maintenance costs are going down, and in general, it looks as if the industry is close to a satisfactory solution of the fuel tank problem.

So far, service experience with bladder cells, the third type of fuel container, has been insufficient for a complete evaluation. Leak detection was said still to be difficult.

The trials and tribulations experienced in developing a pneumatic system for the XB-46 4-jet-engine propelled 93,000-lb bomber were related by another speaker.

Weight and space considerations, as well as the extreme speed of operation required, eliminated electrical and hydraulic power from consideration, he reported.

The achievement was: 1-sec bomb door operation, retraction of main landing gear and doors closed in 5 sec, and split-second application or release of brakes.

Other advantages of pneumatics were said to include: elimination of fire hazard due to leaks, and ability to store energy for operation while on the ground so that on take-off the engines are not robbed of power for retracting the landing gear.

Many problems still appear to need solving, such as: finding seals that don't bond themselves to the cylinder wall; design of pressure regulators with a spring rate sufficiently low so that temperature changes and very small adjustments do not cause high pressure changes, relief valves that last longer, and pneumatic ground starters, especially for jet engines.

Hydraulic Packings

The packing – one of the weakest points in present-day hydraulic systems – was reported to be the subject of a vast amount of research.

The O-ring packing, used in aircraft since 1942, was said to have proved relatively satisfactory and is the best all-round hydraulic packing design. It was admitted, however, that it has a tendency to extrude under high pressure and to fail by so-called spiral failure. In fact, discussion brought out that it may be necessary to use some material other than synthetic rubber for them.

Ice Prevention

A report was presented on a new method of designing for ice prevention that has been successfully applied to the DC-6.

This method is based on fundamental research into the problem, and supplements the empirical methods used on earlier designs. The new theory was said to call for less heat applied to the heating area, more intense heat on the leading edge, and for a variation in the distribution of heat along the wing span.

In developing the method meteorological conditions conducive to the formation of ice were studied at the same time that flight tests were made in natural-icing conditions with two 8-ft-chord heated airfoils.

Cockpits Redesigned

Progress was reported by a Navy speaker on the simplification of cockpit layout. Basically the approach is one of establishing the operator's position, analyzing the data he must receive, and then classifying them for optimum presentation. Certain principles have been laid down, such as:

1. Automatic controls should be used where

they reduce the number of controls and do not endanger the safety of the plane.

2. Controls should have a simple, logical association between their movement and the results they effect.

3. Controls and instruments should be grouped by association with unique conditions or situations.

4. Positions of different controls and instruments should be so related as to give the maximum degree of check-off by noting simple relationships between them.

5. Controls and instruments should be held to an absolute minimum.

Such an approach establishes, it was emphasized, not a standard cockpit but rather a standard philosophy for the design of cockpits for all types of plane. It was pointed out in discussion, though, that the Royal Air Force standard instrument panel used on all RAF aircraft has both economic and military advantages.

It was generally agreed that the approach advocated is a sound one and hope was expressed that a plane using the layout proposed would be built and tested.

Production Problems

As one more link in the chain of savings being effected to keep the design and manufacturing costs of airplanes to a minimum, it was reported that more and more manufacturers are turning to the decimal dimensions on their drawings. In fact, it appears that this system is on the verge of complete acceptance by the aircraft industry.

This system was said to have many of the advantages of the metric system, such as simplified addition and subtraction, less drafting errors, ease in reading, less mental confusion in using, and no need for fractional equivalent transpositions. At the same time, unlike the metric system, little opposition to its adoption was met. It was reported that the average company takes 2-4 years to make a complete change-over.

Another speaker stressed the importance of the design engineer in attaining functionally better airplanes at lower cost, for by his drawings and specifications, he establishes the minimum cost of the plane. The degree of factory efficiency, tooling ingenuity, and purchasing resourcefulness determines how closely the factory approaches this minimum, but it was emphasized that the factory cannot reduce the cost below the minimum established by the design engineer.

Costs under the control of the design engineer were said to include raw materials, equipment, labor, and tooling.

The Saturday forenoon Air Transport Session was closed to reporters, and no summary of what transpired there is included in this report. The paper by Marvin Whitlock, American Airlines, Inc., originally scheduled for presentation at that session, was withdrawn and not presented.

Based on discussions and nine papers presented at four Powerplant Sessions under chairmanship of **John Young, W. J. Blanchard, Ivar Shogran** and **N. C. Price** . . . "Design of Fire-Safe Electrical Systems for Aircraft," by **T. M. Dahm,** Lockheed Aircraft Corp.; "CAA Aircraft Fire Prevention Developments," by **H. L. Hansberry,** CAA; "Future Power for the Personal Airplane," by **J. W. Thorp,** Thorp Aircraft Corp.; "Reduce Airplane Noise Through Basic Design," by **W. E. Burnham,** Beech Aircraft Corp.; "The Allison V-1710 Exhaust Turbine Compounded Reciprocating Aircraft Engine," by **Dimitrius Gerdan** and **J. M. Wetzler,** Allison Division, GMC; "Engine Compounding for Power and Efficiency," by **E. F. Pierce** and **H. W. Welsh,** Wright Aeronautical Corp.; "The Metallurgical Aspects of Gas Turbine Wheels and Nozzles," by **E. M. Phillips,** General Electric Co.; "Turbine Engine Blading: Manufacturing Techniques and Fastening Methods," by **A. T. Colwell** and **R. E. Cummings,** Thompson Products, Inc.; and "Electric Analog Studies for Turboprop Control Systems," by **G. A. Philbrick,** Philbrick Researches, Inc. **W. T. Stark** and **W. C. Schaffer,** Wright Aeronautical Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

Recent Gas Turbine Progress Analyzed

THE reciprocating engine pure and simple was definitely in the background at this meeting as far as large, high-powered powerplants are concerned. The only papers about reciprocating units discussed compounding them with turbines or jet stacks to increase their performance. The gas turbine, on the other hand, was analyzed from several points of view: metallurgy, manufacturing techniques, and control.

A new approach to the noise nuisance was advocated, and the future of light engines was discussed. Other papers covered fire prevention, an ever-important subject on which much work still remains to be done.

Compounded Engines

A revolution appears to have taken place in the aircraft powerplant field in the past few years. The reciprocating engine, which dominated the field for 45 years, seems to be giving way to the turboprop, turbojet, ramjet, and even the rocket.

Some engineers are convinced, however, that the reciprocating engine will continue to be used for certain specialized applications. In particular, according to one speaker, it will be used where thermal efficiency and low fuel consumption are

the most important considerations, for in this area he still considers it to be superior. Where low engine weight is more important, the turbine apparently will reign supreme.

Although some improvement in the performance of reciprocating engines can be made by modifications in mechanical efficiency, compression ratio, mixture strength, and ignition timing, the greatest possibilities for additional power and efficiency were reported to be in recovering heat from the exhaust system.

An extensive analysis of the power recovery problem came up with the following conclusions:

1. At low altitudes and high speeds, the jet stack system (in which the momentum of the exhaust gas is converted to thrust by means of stacks) appears best.

2. At low and medium altitudes, moderate speeds, and long range, the blowdown turbine system (in which kinetic energy of the exhaust is converted to useful power through a turbine) excels.

3. At very high altitudes, the pressure turbine system (in which the exhaust is collected in a manifold to be discharged in a steady flow) and the double compounded pressure blowdown system (in which a blowdown turbine and pressure turbine system are in series) are practically without competition.

The field of power recovery engines was said not to be entirely limited to long-range operation. It was reported further that power recovery engines of the blowdown type can be built within the same cowl line and with very little increase in engine length, and deliver 15% or more take-off power for almost the same size.

One speaker described how a geared exhaust-driven turbine was added to the rear of the first stage of an Allison V-1710-E-27 2-stage supercharged engine. Although the development has since been dropped (because it was felt that the time could be better spent on the turboprop engine) tests did show that a marked improvement in cruising fuel consumption can be attained.

At 19,000 ft a conventional single-stage engine having the same compression ratio and blower ratio developed 950 hp with a cruising consumption of 0.480 lb per bhp-hr, whereas the turbine compounded engine developed 1040 bhp with a fuel consumption of 0.395 lb per bhp-hr – or a reduction of almost 18% in fuel consumption.

Unfortunately, at certain conditions the exhaust gas temperatures were too high for safe operation with the turbine used in the tests, so that it was not possible to operate at best economy fuel-air ratios without endangering the turbine. It appeared that exhaust turbines would have to be designed to withstand gas temperatures of 1800-1900 F.

The successful application of the gas turbine as a prime mover was delayed many years, another speaker reported, by the lack of metals capable of withstanding the high temperatures essential to efficient operation. Thus, he continued, it has been necessary to expend a vast amount of effort on the development of materials for such parts as wheels, nozzles, and blades.

In discussion, it was pointed out, though, that the time has come for us to expand our knowledge of the properties of alloys already available, not only for the sake of design information, but to acquire product uniformity. We are still unable to utilize properly some of these alloys, the discusser said, because we lack the means for economical fabrication of parts. We should devise more satisfactory means for forging blades economically from available materials, he continued, before concerning ourselves about alloys even more difficult to handle.

Some progress along these lines was reported, although at the same time it was admitted that the surface had hardly been scratched as far as reducing costs and making parts to closer tolerances by way of advances in engine design alloys and improved manufacturing techniques.

At present, one speaker said, it is desirable to hold parts as closely as is commercially practicable, as it is not yet known just what loss in performance occurs when buckets, blades, and vanes vary from the ideal airfoil contour.

Apparently lowest costs are to be expected when these parts are made by wide limit or precision forging plus finishing operations. Cost is a serious matter, he said, because blades, buckets, and vanes may total 2000 or more in a single engine.

For the moment the trend seems to be toward forging buckets and blades, although other methods, such as investment casting plus finish operations and machining from bar stock, will also continue to be used. Precision was reported as increasing on all three methods.

According to the speaker, the best all-round method of attaching the buckets is by the British loose-fit, fir-tree root. The blade attachment, being one of the most highly stressed points of the machine, must make efficient use of material. The general aim is, he said, to obtain uniform loading on the teeth and to reduce regions of stress concentrations as much as practicable.

Turboprop Control Systems

A new research tool called the analog was said to solve almost instantaneously problems in the design of turboprop control systems that would take days of calculation and testing by the older analytical and empirical methods. The device presents an oscilloscopic time plot showing the behavior of important variables. It is thus possible to explore quickly all possible combinations to establish the optimum design. The analog is composed entirely of electronic components, which are widely adjustable to simulate any particular designs of turboprop engine and control system.

The pure jet engine is not expected to take over the low-horsepower field for a good many years, for it was stated definitely that at the speeds the private pilot can afford, the propeller still does a better job of producing thrust than does the jet.

One speaker did predict, though, that the turboprop may soon challenge the estate of the reciprocating engine in this field, for the gas turbine is one of the most promising avenues for the exploration of weight reduction, which would make possible much lighter and more compact planes than heretofore. Before this happens, however, certain troublesome problems need solving, such as: reducing fuel consumption, speed reductions of 10 to 30 to 1, and a sufficiently powerful starting unit.

Meanwhile, the speaker sees a trend toward simplified engine structures paralleling that of the automobile field. Thus the small size engine may soon be a 4-cyl, in line or square 4-cyl arrangement, cast en bloc.

As emphasis on vision increases, the speaker prophesied that the inverted inline engine would come back into vogue. However, the horizontal opposed engine will continue to retain its popularity for some time to come, he said. If the good installation features of all opposed engines were combined and the bad features eliminated, he felt the result would be an engine sure to retain its present acceptance for a much longer period than it otherwise would.

Two low-cost approaches were suggested as deserving of further study: the now almost forgotten 2-cyl opposed arrangement and the 2-stroke cycle (despite starting problems, high specific fuel consumption, unstable idling, and noisy exhaust, for the author pointed out that all these difficulties are capable of practical solution).

He does not foresee the use of automobile engines in airplanes, for the weight disadvantage of this type of engine and its cooling system would dictate larger and more expensive airframes, which would increase total costs beyond the amount that could be saved on the engine.

Noise, perennial headache of the low-horsepower equipment manufacturers, was suggested as more likely to be solved by attempting to reduce it at the source than by loading the plane with more and more insulation, which is expensive in terms of weight and space, and does not help to reduce the noise for people outside the plane.

The propeller was admitted to be the worst offender, but one bright spot appears in the picture: the propeller required for best efficiency is also the least noisy. Controllable-pitch propellers were said to be more effective than the 2-speed gear box, but, in the final analysis, the only solution was reported to be to reduce tip speed, which boils down to slow rpm and large diameter. If propeller noise is reduced, it was pointed out, other noises will have to be reduced. It will then be necessary to develop a muffler that really works, which it appears present-day ones do not.

Fire Prevention

A progress report on the CAA fire prevention program revealed that the subject is being studied from many angles, such as, the development of a fire-resistant doped fabric, noninflammable hydraulic fluid, fire resistant lines and fittings for the vacuum or air pumping system, effect of engine fire on integral wing tanks, engine fire ignition sources.

With much work still to be done, a few tentative conclusions have already been reached. Several noninflammable materials have been discovered, for instance, that may be used as hydraulic fluids. Incomplete tests were also reported to indicate that so-called safety fuels give no added safety over regular gasoline.

SAE Past-President Mac Short, left, with Capt. L. D. Webb, Aircraft Industries Association, Thomas Wolfe, vice-president of Pan American World Airways System, and John Stack, National Advisory Committee for Aeronautics

TRUCK REQUIREMENT ANALYSIS

Name of company or owner: Nonstop Hauling Company
Address: 145 West Avenue City: Central City, Michigan
Type of business: Over-the-road haulers Location (where truck used): Michigan
Type of Operation: (Check one) ☒ Intercity ☐ City or suburban ☐ Off-the-highway
Comments: Light traffic

Materials to Be Hauled: General freight Maximum payload: 16 tons lbs.
Weight: Per: Size containers:
Body: Type: Semitrailer Dimensions: 30 feet Weight: 11,000 pounds
Comments: Noninsulated -- closed. Tandem axle.

Operating Conditions: Roads: (Check one) ☒ Paved ☐ Unimproved
Terrain: (Check one) ☒ Level ☐ Rolling ☐ Mountainous Maximum grade: 3 %
Comments: Less than 5 per cent of route is uphill.

Hauling Conditions: Daily mileage: 300 Hours operated daily: 10 Loaded both ways: Yes
Payload: (Check one) ☐ Fixed maximum load ☐ Variable load ☐ Diminishing load
Comments: Hauling conditions favorable. Modern streamlined semitrailer.

States in which Vehicle Will Operate: Licensed in: Michigan
Operated in: Illinois and Michigan
Performance Requirements: Maximum operating speed on level roads: 45 miles per hour
Schedule requirements: 300-mile run in 10 hours
Comments:
Company: Nonstop Hauling Company
Date: 1-2-50 By: L. D. Jansen (Signature)

TRUCK APPLICATION RECOMMENDATION

Truck or Tractor: Make Model Wheelbase Tire size
Approved gross vehicle weight
Load distribution, total GVW: Front lbs. % Rear lbs. %
Engine: Model Brake horsepower: 134 at 2800 r.p.m.
Performance: Maximum road speed: miles per hour
Ability (full load): Negotiate a % grade at miles per hour
Transmission: Model Number forward speeds Direct in Aux. trans.
Rear Axle: Model Type Ratio
Brakes: Type
Electrical Equipment: Generator: Volts Amp. Battery: Volts Amp. hr. cap. No. plates
Other Equipment:

Fig. 1

8 STEPS T

BASED ON PAPER* BY

J. N. Bauman

VICE-PRESIDENT
WHITE MOTOR CO.

EIGHT steps – taken in order – are necessary to match trucks to their jobs effectively. They are:

1. Determine what the truck has to do;
2. Determine the horsepower needed;
3. Select the model with the right capacity, wheelbase, and load distribution;
4. Select proper tire sizes and types;
5. Select axle best suited for the work;
6. Determine rear-axle ratio which will produce greatest operating economy;
7. Select the transmission which will give most efficient operation;
8. Select optional equipment items which will give best possible results.

Regular application of these eight steps in selecting trucks would complete the engineering cycle which begins with design, following it through to responsibility for most efficient use of the vehicle. Failure to take the proper steps in selection has resulted in tremendous waste and has hindered development of the motor transport industry.

The Truck's Job

Lack of advance knowledge of what is expected of a truck has probably been the most important cause of improper truck application. The user has never understood exactly what the supplier must know about the work the truck is to do.

A "Requirement Analysis" form helps greatly to improve the buyer's understanding. (See Fig. 1.) On this form is space to record all the essential information the supplier needs to indicate the right truck for the particular work.

Determining Horsepower

Horsepower is used to measure performance needs because it is the only readily available measurement of truck performance that is published and usable. It is also one of the elements in the recommended measurement of truck performance adopted by SAE.

An engineering analysis of the work to be done is the base upon which horsepower needs are determined. Criteria for making this determination, based on years of research and operators' experience, are:

City or Suburban Operation
(Straight Truck – 20 mph up a 5½% grade net)
(Tractor-Trailer – 20 mph up a 3½% grade net)
Intercity Service
(Straight Truck – 20 mph up a 5% grade net)
(Tractor-Trailer – 20 mph up a 3% grade net)

This performance measure was adopted because of its uniform application and simplicity. It is convenient – but not universally applicable. Most

*Paper "Truck Application" was presented at SAE National West Coast Transportation and Maintenance Meeting, Los Angeles, Aug. 22, 1947.

To Correct TRUCK APPLICATION

SERVICE RATING FACTORS FOR CITY- OR SUBURBAN-TYPE SERVICE*

TYPE OF RUNS	Long or medium city and suburban runs on normal schedules					Large number of short fast runs between frequent stops on hard-working schedules				
Service Rating Factor	1.0					1.05				
MAXIMUM LOADED SPEED— m.p.h. governed	35 m.p.h.		40 m.p.h.		45 m.p.h.		50 m.p.h.		55 m.p.h.	
Service Rating Factor	1.00		1.00		1.02		1.04		1.06	
AMOUNT OF HILLS— Proportion of loaded truck mileage going uphill to total mileage	5%	10%	15%	20%	25%	30%	35%	40%		
Service Rating Factor	1.0	1.01	1.02	1.04	1.06	1.08	1.09	1.10		
PER CENT GRADES— Maximum Gradient (500 ft. long or more)	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
Service Rating Factor	1.0	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09
ROAD CONDITIONS	Paved		Unimproved dirt, graded and firm		Considerable snow and ice		Rough, hard dirt or rock bed		Mud, deep sand, wet clay	
Service Rating Factor	1.0		1.02		1.03		1.05		1.10	
TRAFFIC	Light					Heavy				
Service Rating Factor	1.0					1.05				

*Also dump trucks or special projects—off-the-highway-type service

Fig. 2

operations involve conditions which are other than normal. So every case has to get special consideration to see if it is going to deviate from the normal.

To do this, each factor influencing horsepower is set up with a definite factor evaluation in proportion to its influence on power requirements. Figs. 2 and 3 show the factors which White's organization has given to these various conditions.

Model, Wheelbase and Load-Distribution

The model, the proper wheelbase and the load distributions are decided by the nature of the work to be done. Capacity is recognized as gross vehicle weight; the weight of the chassis, body and payload represent the task that the truck has to perform.

Here, again, no two operations are exactly alike.

By establishing a table of factor evaluations for operating conditions affecting carrying capacity, we can determine the classification for any job by taking the factor for each condition and multiplying them together. The amount of the product then establishes the gross weight classification. This is then translated into an (a), (b), or (c) classification; (a) being favorable; (b) moderate; (c) unfavorable, by checking the classification into which the factor falls.

Fig. 4 shows table of the factors used for evaluating operating conditions in terms of gross vehicle weight rating.

When the model has been selected, wheelbase must be determined – which requires establishment of load distribution as well.

Normal distribution between front and rear axle is 75% on the rear and 25% on the front – for a conventional truck. Normal for cab-over-engine jobs is 70% on rear and 30% on front. But this varies with different types of operation. So, the service must be checked to see what is needed from the particular unit. From this, we can determine the wheelbase necessary to give the proper load distribution.

Tire Selection

Tire selection is simple; its simplicity should not result in lack of proper consideration. The needed tire capacity rating is related to the already-determined load distribution, while selection of tread or special tires depends on the type of service.

Selecting the Axle

Single-reduction, double-reduction and two-speed axles each has a specific purpose – which is related to operating conditions.

The single-reduction unit, because of its light weight and simple design, should be used every-

SERVICE RATING FACTORS FOR INTERCITY-TYPE SERVICE

SPEED—M.P.H. Maximum normal running speed or cruising speed		40	45	50	55	60
Service Rating Factor	30,000 g.v.w.	1.00	1.12	1.34	1.64	1.98
	40,000 g.v.w.	1.00	1.00	1.17	1.39	1.65
	50,000 g.v.w.	1.00	1.00	1.05	1.23	1.44
	60,000 g.v.w.	1.00	1.00	1.00	1.16	1.34
	70,000 g.v.w.	1.00	1.00	1.00	1.08	1.25

AMOUNT OF HILLS—Proportion of loaded truck mileage uphill to total mileage	5%	10%	15%	20%	25%	30%	35%	40%
Service Rating Factor	1.0	1.01	1.03	1.04	1.06	1.08	1.09	1.10

PER CENT GRADE—For the steepest long grade (1,500 feet long or more)	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%
Service Rating Factor	1.0	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09

ROAD CONDITIONS	Paved	Unimproved dirt—graded and firm	Considerable snow and ice
Service Rating Factor	1.00	1.02	1.03

TRAFFIC	Light	Heavy
Service Rating Factor	1.0	1.02

STREAMLINING	GOOD (Full, round front, smooth sides, streamlined tail—combined with high speed of 50 m.p.h. or more)	NORMAL	POOR (Square front, ribbed sides, square rear, large area rear—combined with high speed of 50 m.p.h. or over)
Service Rating Factor	.97	1.0	1.03

Fig. 3 (above)

CAPACITY RATING FACTORS FOR GROSS WEIGHT CAPACITY RATING

TYPE OF LOAD	Fixed load, rapidly diminishing type of operation	Fixed load	Maximum loads with some high peaks and many light loads	Normal maximum load and some high peaks
Capacity Rating Factor	1.07	1.05	1.03	1.0

METHOD OF LOADING	Loading from power shovel with dipper over 2-yard capacity	Loading from power shovel with 2-yard dipper, or smaller	Oil field winch loading, or truck mounted crane loading, or its equivalent	Hand, or hand truck, or conveyor loading
Capacity Rating Factor	.90	.94	.96	1.0

ROAD CONDITIONS	Off the highway—in excavation, or rough quarry floors, or rough oil field, or logging trails	Unimproved or rather rough highways, or some off-the-highway work	All pavement, improved roads with some rough streets or highways	All good, smooth roads
Capacity Rating Factor	.92	1.00	1.05	1.07

SPEED—M.P.H.—NORMAL RUNNING SPEED—	20	25	30	35	40	45	50	55	60	65
Capacity Rating Factor	1.07	1.05	1.03	1.02	1.01	1.00	1.00	1.00	.98	.96

CALCULATING THE TOTAL CAPACITY RATING FACTOR

1.05	×	1.00	×	1.07	×	1.01	=	1.13
Type of Load		Method of Loading		Road Conditions		Speed		Total Capacity Rating Factor

Fig. 4

where it is possible to get a numerical gear ratio of an adequate amount. It is usually limited to a 7.21 gear ratio. Double-reduction axles are for higher ratios or when a single reduction of adequate capacity is not available . . . Two-speed axles are used primarily for more flexible gearing.

Selection of proper rear-axle ratio gives us our last chance to place the engine in balance with speed and load. This is necessary to get maximum fuel economy and operating engine life.

Rear axle ratio should be determined on the assumption that the truck will operate in direct drive during most of its loaded operation. The speed at which the user wants to operate has to be known. This "cruising speed" is approximately 10% lower than the top governed speed. So, by setting the gear ratio in the rear axle so that the top fully loaded speed on level road will be attained in direct drive, at somewhat less than governed engine speed we will have the most economic operating range for the engine.

This is accomplished by reducing the governed engine speed by 5%; then setting the rear axle ratio to attain maximum fully loaded speed on a level road in direct drive at this reduced engine speed. With this cruising speed, we determine the rear axle ratio, after knowing the tire size.

Choosing the Transmission

There are three generally used types of transmission – four-speed, five-speed; and auxiliary.

The four-speed is used primarily for city and suburban work – and essentially on lighter equipment. (It is, of course, direct in fourth). The five-speed comes into direct in fifth as well as direct in fourth with an overdrive. (The overdrive is used chiefly where the truck or tractor-trailer is loaded only one way and makes the return trip empty.)

The auxiliary transmission furnishes further reductions to make available greater starting torque – and splits gears in the regular transmission to negotiate long grades with higher speeds and greater efficiency.

Optional Equipment Items

Final step is to select the right optional equipment items. This includes determining the proper weight of springs; type of brakes; generator capacity; and such things as gas tanks and safety items.

Conclusion

All of these eight steps are necessary if we hope to fit a truck accurately to its job. Both user and manufacturer should give proper planning and thought to applying trucks to the work they are expected to accomplish.

If proper consideration is not given to truck application, the motor transport industry will always be penalized by higher costs than are necessary and its full potentials will not be attained.

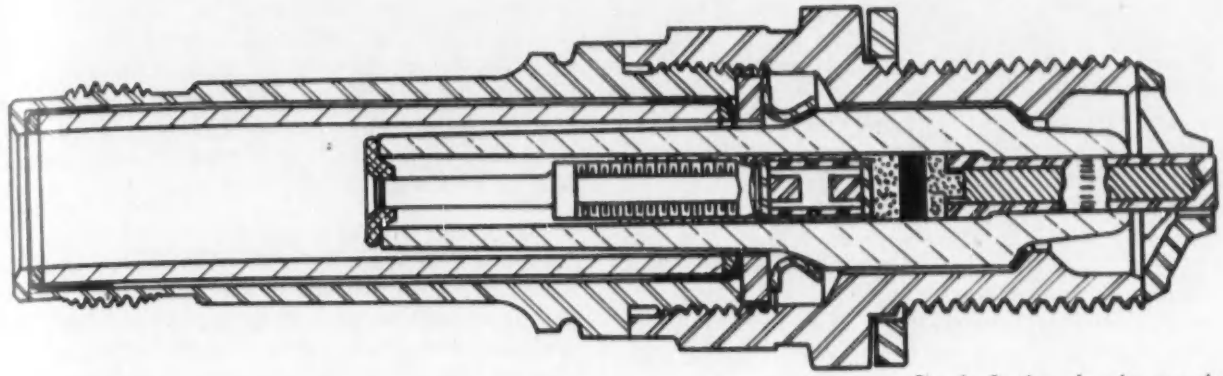


Fig. 1 – Section of series-gap plug

NEW MATERIALS

Increase Spark Plug Performance

BASED ON A PAPER* BY

W. A. BYCHINSKY

Chief Engineer, AC Spark Plug Division, GMC

(This paper will be published in full in SAE Quarterly Transactions)

THE spark plug must satisfy two simple and easily met requirements: it must conduct high-tension current into the combustion chamber, and it must furnish a pair of electrodes between which the voltage can spark.

Much more difficult to satisfy are the negative requirements, which impose severe limitations on both materials and design. The spark plug must not interfere with the functioning of the engine. It must not break or disintegrate. It must not run at a temperature so high as to cause pre-ignition. It must be small enough to be located at the point in the chamber where ignition should be initiated, and it should not interfere with the engine cooling. It should not create an extraneous load on the ignition system, such as from fouling of the insulation surface by electrically conducting coatings. It should not change its ability to produce a spark with a given voltage, that is, the gap should not change, and the sparking voltage should not vary. It should not be affected by the engine. The materials of the plug should not be attacked by the fuels or products of combustion at the highest engine temperatures encountered. Nor should they be affected by the rapid changes in temperature to which they are exposed.

Stiffer Operating Conditions

The high operating speeds, wide speed range, high compression ratio, high specific output, and economy of the present-day engine have made the job of overcoming these limitations a particularly tough one, requiring continued research, investigation, and development.

Translated into spark-plug requirements, this means that the plug must be able to operate over wide ranges of speed, pressure, temperature, and air-fuel ratio.

Furthermore, the addition of such detonation

* "Factors Affecting the Functioning of Spark Plugs," was presented at a meeting of the Pittsburgh Section of the SAE, Pittsburgh, Pa., March 25, 1947.

inhibitors as tetraethyl lead has greatly influenced spark-plug behavior. Plugs must also be adaptable to servicing or reconditioning. The use of the one-piece, nondemountable plug (that is, the insulator cannot be removed for cleaning) was made possible by the development of spark-plug cleaning devices. Special needs that may be more important in the future include moisture proofing and radio shielding. Cost must also be given proper consideration.

The electrodes must be able to resist high temperatures, corrosive gases, and erosive electrical discharges; nevertheless, they should be reasonably good thermal conductors, they should permit the formation of a spark discharge at a low, constant voltage, they should be easily fabricated, and they should be available at low cost.

Materials

These specifications are not fulfilled in their entirety by any known metal or alloy; the nickel-chromium-barium alloy currently used on many plugs does, however, satisfy many of them. The nickel and chromium contribute corrosion resistance, but the reason underlying the addition of barium is more obscure. Some years ago it was discovered that the so-called work function of materials exposed on the surface of electrodes greatly influences the sparking voltage. The nickel alloys then used were found to be quite erratic in their sparking voltage because of the uneven distribution of magnesium (customarily added to deoxidize the melt) in the electrode. Magnesium has a low work function that greatly affects sparking voltage. Barium was found to be especially well suited to act as a low work function metal that could be alloyed with the electrode material to ensure uniformity of distribution. This alloy is known as isovolt because the sparking voltage of electrodes made from it remains constant.

In selecting the insulator material, consideration must be given to the mechanical, thermal, electrical, and chemical conditions under which it is to operate. The direct mechanical loads imposed by the engine, even at extreme outputs, are small compared with the loads imposed to ensure gas-tight operation. Mechanical loads often encountered during installation or removal of plugs merit the use of the highest strength insulators available. Alumina is outstanding in this respect.

Resistance to heat shock, which has been the subject of intensive investigation, was greatly enhanced when the mullite body, now in general use, replaced porcelain. The new alumina body making its appearance is a further improvement in this respect. In addition it possesses high thermal conductivity, which permits the use of long tips on high-output (or cold) plugs.

Chemical reaction of the insulator tip with products of combustion is of prime importance. Lead has a particularly deleterious effect on some ceramic materials, for it forms a low melting point lead silicate glass, which is chemically active and a good electrical conductor at high temperatures. At one time most plugs had glazed tips, that is, the tips were coated with glass having a high silica content, to retard the attachment of carbon. With the introduction of tetraethyl lead, it was found desirable to eliminate this glaze to retard the reaction of the lead salts.

Electrical Requirements

As any fouling will cause a certain amount of leakage, voltage should build up rapidly. This is precisely the principle used in high-frequency ignition systems, where, instead of taking 1/20,000 sec for the voltage to reach its peak, it may take less than 1/1,000,000 sec. High-frequency systems have demonstrated their ability to fire plugs so badly fouled that their electrical conductivity is of the order of 2000 micro-mhos, whereas conventional systems may fail with only 5 micro-mhos. Although high-frequency systems have been used on aircraft, there is little likelihood of their use on transportation vehicles in the near future because of their high cost.

Closer at hand is the series gap, or intensifier gap, another high-frequency system that has also seen service on aircraft. Fig. 1 shows a view of the plug used. If certain complex critical relationships between the series gap and the plug gap are fulfilled, the equivalent of a very-high-frequency ignition system is obtained. Great difficulty has been encountered in building reliable series gaps, but the problems involved are well on the way to an economic solution. It is not unlikely that spark plugs containing built-in series gaps will soon be considered for certain vehicle applications.

Thermal Requirements

With the introduction of new insulator compositions having markedly different heat-conduction characteristics and with the development of new insulator shapes, better methods of characterizing the operating temperature of the spark-plug tip were needed.

In widest use today is the imep (indicated mean effective pressure) preignition rating. By this method a plug is run at successively higher engine outputs until preignition is encountered. The maximum indicated engine output, expressed in terms of imep, which the plug can withstand without preigniting is the imep preignition rating of the plug. The measurement of the high-temperature characteristics of the plug is thus made at the maximum temperature at which the plug can, or at least should, be operated. It is not necessary, therefore, to extrapolate performance at high temperatures from data obtained at some lower temperature.

The variables entering into the determination of preignition rating are numerous. Consistent and

reliable values are obtained only with complete control. In the first place, the engine must be designed to eliminate the possibility of preignition from all engine parts at the highest output at which plugs are to be rated. In practice the engine is checked with a calibration plug known to have a rating substantially above that of the plugs to be run. If preignition is observed with the extremely cold calibration plug the cause cannot be due to the plug.

Since the average combustion gas temperature depends on the air-fuel ratio, means are provided to vary this ratio while measuring the average combustion gas temperature with a thermocouple mounted in the combustion chamber. The fuel mixture is set for maximum temperature for each engine setting by adjusting the stroke of the fuel injector pump. The intake air is held at constant temperature and humidity.

The fuel must have an octane rating greater than 100 so that detonation-free operation is obtainable at the highest output, since temperature rise from detonation would present an uncontrollable factor in the heating of the plug.

The engine output level is varied by varying the intake pressure from below atmospheric to a high degree of supercharge. In an actual test the amount of boost is increased in increments of ½ in. of hg, adjusting the fuel for maximum temperature at each setting and allowing the plug and engine to stabilize before the next increase. When preignition occurs there is a falling off of load and a sudden change in the rate of rise of the combustion-chamber temperature. The latter indication is more reliable in the early stages of preignition.

Although much research has been done to devise a test rating the ability of a plug to resist carbon fouling, complete success has not yet been attained.

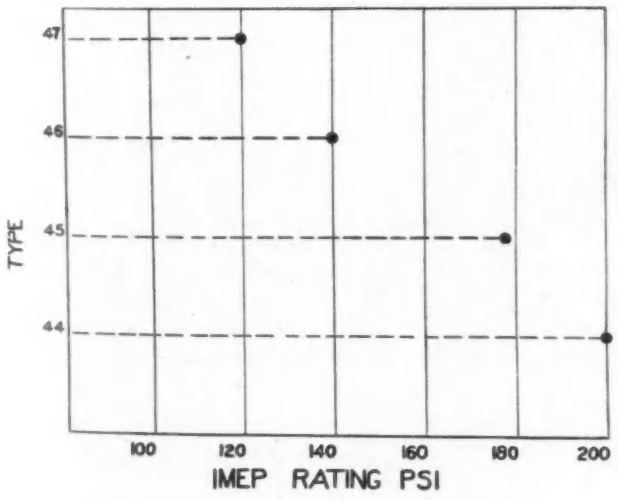


Fig. 2 – Imep ratings for several spark plugs

Meanwhile, however, new methods of forming the insulator have been developed that remove the limitations formerly encountered with clay bodies. As a result it is now possible to manufacture insulators having very thin recessed tip sections that, because of their low mass, can more readily follow temperature changes in the combustion chamber and so operate for a greater percentage of the time at temperatures sufficiently high to burn off, or at least to retard, the deposition of carbon. Along with the ability to form and fire such insulator shapes, it was necessary to have an insulating material of the requisite strength, heat shock resistance, and imperviousness to attack by fuel components at elevated temperatures. Alumina is such a material.

Plug Selection

Having considered the factors involved in determining the operating temperature of a spark plug, let us now apply them to the selection of the optimum heat range plug for a particular engine. The temperature that the insulator tip should reach to prevent, or at least retard, the deposition of carbon is the same for all plugs in all engines. The temperature that must be reached by the plug before preignition is incurred is similarly independent of engine and plug. Regardless of engine and plug, therefore, the plug temperature over the maximum possible range should lie between these two limits.

If engine output is high, for instance if we are dealing with a high-compression, high-speed engine running at full load, a condition where combustion gas temperature is very high, then we must use a cold plug, that is, one with a short insulation length or, more scientifically, one having a high imep rating, in order that it can more readily carry away the heat it absorbs from the engine and so will not overheat. If, on the other hand, we are dealing with a low-output engine, that is, one with a low compression ratio, run at low speed and light load, where the combustion gas temperatures are low, then we would choose a hot plug, that is, one with a long insulation length and thus a low imep rating in order that the heat imparted to the insulator tip is restricted in its flow, thereby permitting the temperature of the tip to build up to the required value.

All Types of Operation Covered

In practice, the gradations in imep rating or heat range are small enough to permit the accurate selection of plugs for all types of operation from the lowest-output kerosene burning stationary engine to the highest-output triptane fueled water-injection aircraft engine. In terms of imep ratings this represents a range of from 70 to greater than 500. Typical ratings for common plugs are shown in Fig. 2.

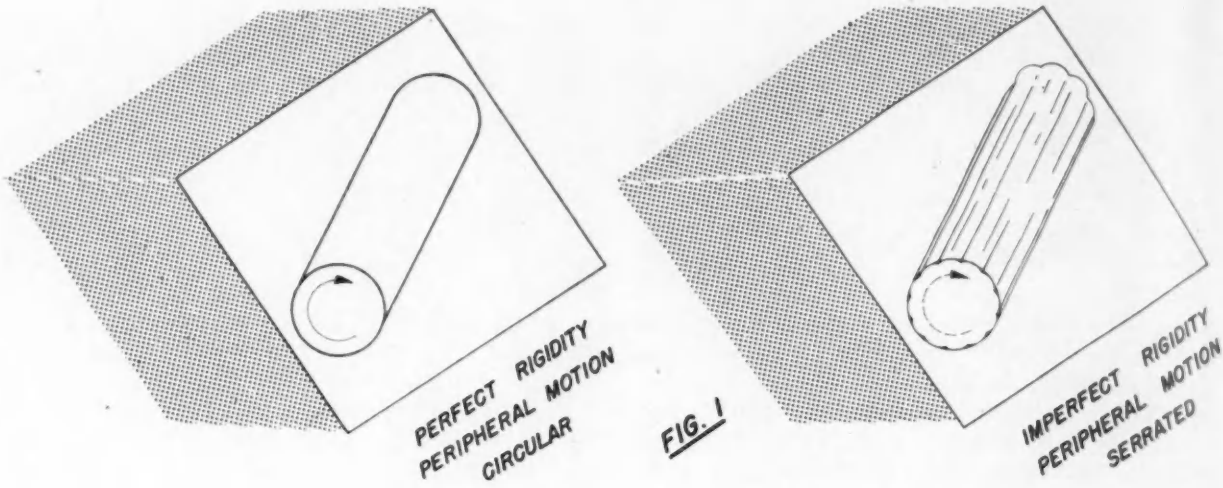


FIG. 1

ABC's of

FALLING back to fundamental concepts often points to direct rather than tortuous solutions of a problem. A case in point is the important – but often overlooked – role played by cylinder surfaces in engine lubrication.

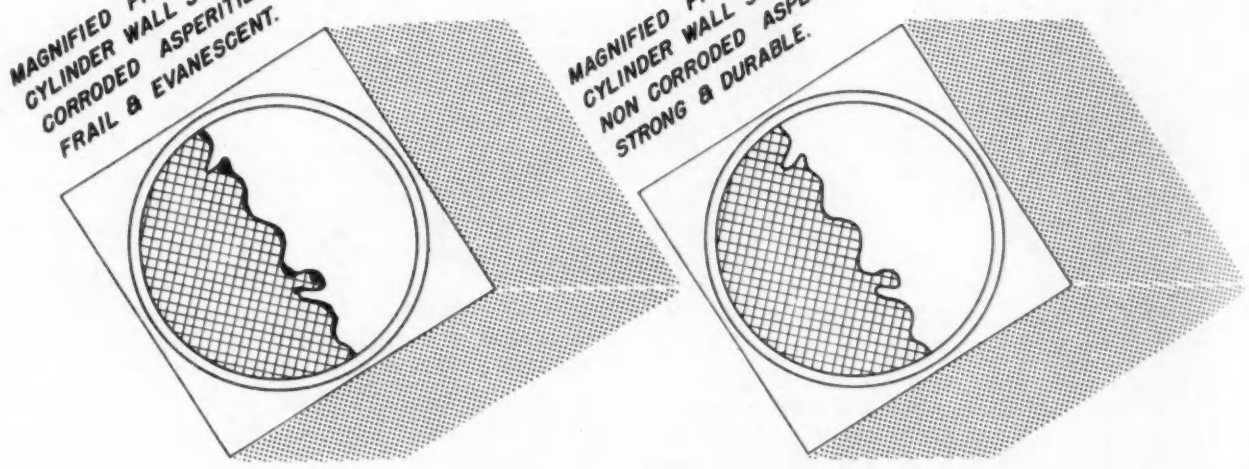
For some reason surfaces are always considered to be exposed portions of rigid mechanical members. The rigidity accepted in theoretical mechanics is not realized in practice, as shown in Fig. 1. Absence of exact rigidity creates eccentricity of motion between moving surfaces away from calculated geometric patterns.

Of small import with full-film lubrication, this varying of motion patterns takes on significance where partial or boundary films exist. Coupling surface roughness – itself a lubrication deterrent – with eccentricity of motion, induces high loadings at localized points.

Conceiving of the projected area in square inches as the bearing area is an incorrect notion; because

* Paper "Lubrication – Its Effect on Reducing Mechanical Wear," was presented at SAE National West Coast Transportation & Maintenance Meeting, Los Angeles, Aug. 21, 1947.

FIG. 3



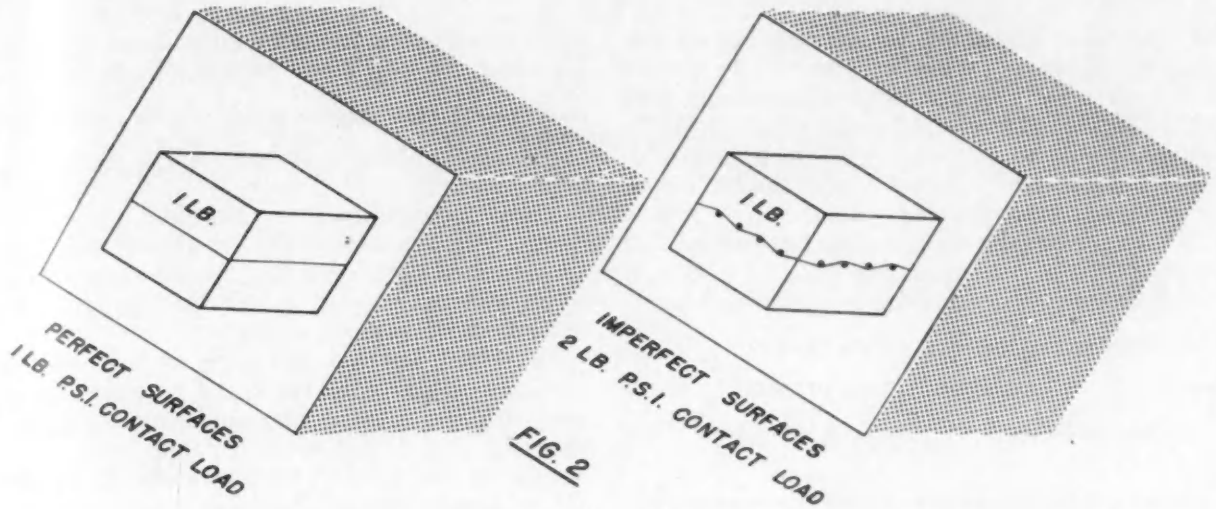


FIG. 2

Cylinder Lubrication

BASED ON A PAPER* BY **W. M. SOPHER**
Union Oil Co. of Calif.

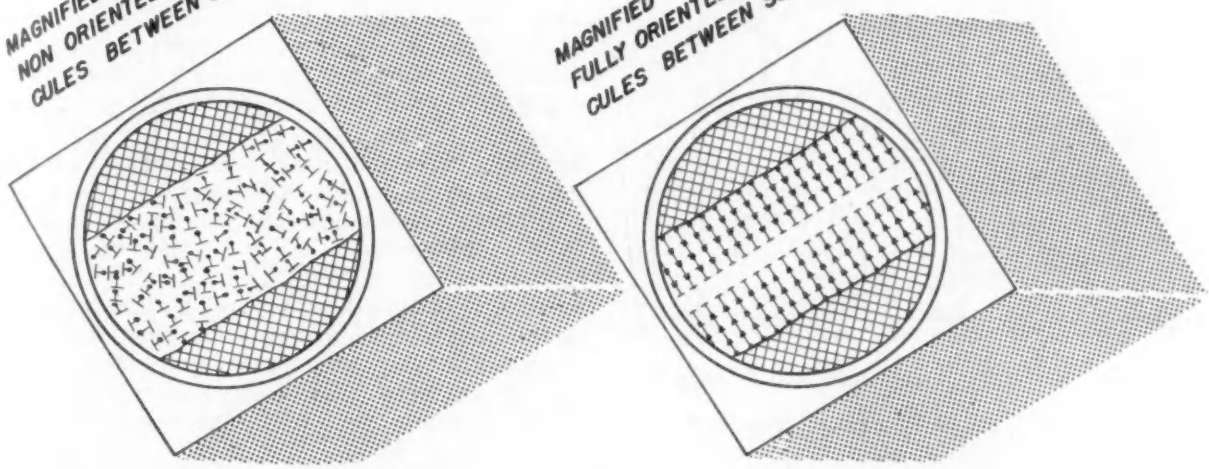
of surface irregularities, only points in contact rather than the entire area offer support. Fig. 2 illustrates this. A 1-in. cube weighing 1 lb distributes its weight equally – 1 psi – provided both surfaces are perfect. Each one-millionth of a square inch carries one-millionth of the 1-lb load.

But surface imperfections would distribute the load differently. Perhaps only 500,000/1,000,000 of the total area would carry the total 1-lb load – a 100% increase in load pressure per unit working area.

Cylinder bore wear has long posed a problem in reciprocating combustion engines. Corrosive effects play a large part in this area. And corrosion stimulates erosive wear. (See Fig. 3.)

Influence of corrosion on cylinder bore wear

FIG. 4


MAGNIFIED CONCEPTION OF NON ORIENTED OIL MOLECULES BETWEEN SURFACES.
MAGNIFIED CONCEPTION OF FULLY ORIENTED OIL MOLECULES BETWEEN SURFACES.

would indicate an unstable or intermittent oil film in the critical area. Work by Prof. C. F. Taylor with a motored engine shows that increasing load and speed substantially increases friction in the cylinder. Yet journal bearings – under complete film lubrication – show no such appreciable effect. Since lubricant viscosity was constant at all points, the frictional increase must stem from partial film lubrication of the cylinder bore.

That cylinder lubrication is a partial-film process can be seen from the $\frac{ZN}{P}$ viscosity value. (Z = viscosity, N = speed, and P = pressure). Low $\frac{ZN}{P}$ values yield boundary or partial films. Because of variation in piston speed from O to N fpm (see Fig. 5), and since combustion chamber heat reduces oil film viscosity, $\frac{ZN}{P}$ values for cylinder lubrication will be largely in the low range. Fig. 6 tells the story.

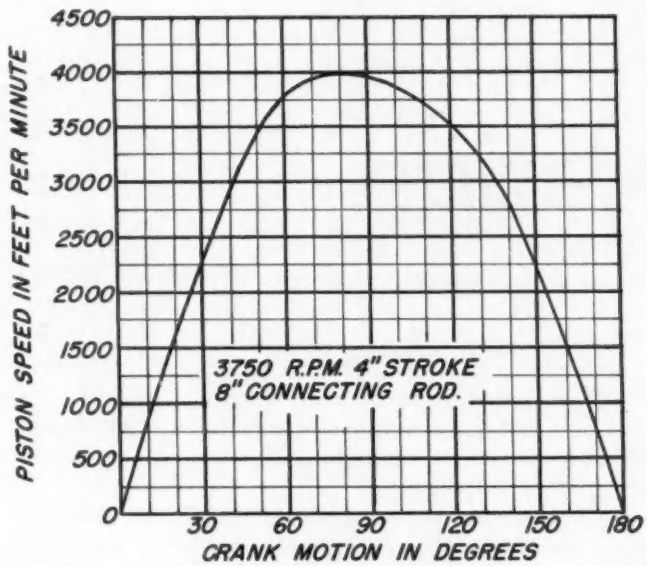


Fig. 5 – The variation of piston speed (in feet per minute) with crank angle

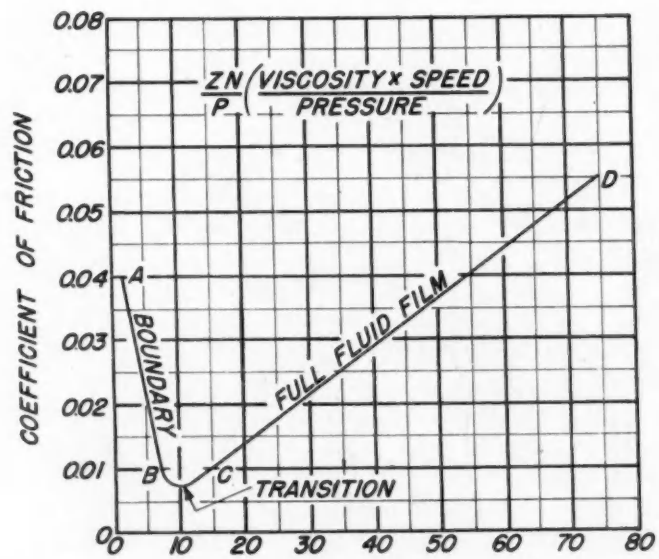


Fig. 6 – Charting values of $\frac{ZN}{P}$ against coefficient of friction bears out the belief that low values of $\frac{ZN}{P}$ produce partial or boundary film lubrication

Many factors tend to diminish lubricant viscosity. To counteract this, much work has been done toward both retarding surface contacts and, as an alternative, toward abating destructive effects of moving surface contacts.

To retard surface contacts by supplementing viscosity, oiliness agents or polar compounds are used. Here forces of intermolecular attraction, as shown in Fig. 4, rather than viscosity or oil shear resistance interpose an unctuous interface between the rubbing surfaces. Since molecular orientation creates a film only five to six angstrom units thick, this approach is yet limited.

A way of mitigating damage from surface contacts is by use of antifusing agents such as sulfur and chlorine compounds. Principle here involves conversion of surface under load. With iron surfaces, stress points are prevented from welding by being converted into oxides, sulfides, and chlorides. Sufficient evidence is on hand to show that compounds of this type substantially reduce erosive wear with high loads and thin lubricating films.

Lubrication of this type substitutes mild corrosion at points where violent erosion would occur without antiwelding compounds.

Oil Itself a Factor

In any lubrication problem we should take cognizance of the influence of the lubricant's service properties. Precepts have been handed down recommending 1000-mile or 60-hr oil change periods to extract a reasonable amount of lubrication purchased. Recent work controverts this approach.

Common conclusion reached in studies of the subject is that significant factors involved in all lubricants undergoing physical and chemical change in service is quantitative rather than qualitative. Thus the question is not "Has the neutralization number changed?" but rather "How much has it changed?" And not "Has the kinematic viscosity of the oil increased?" but "How much has the kinematic viscosity changed?"

Apparently all organic lubricants undergo some change – even with the slightest use or exposure. To apply these materials practically, their service limitations should be calculated on their capacity to perform the specific job rather than on abstract values that are more indicative than conclusive.

The oil change cycle can be greatly extended if we regard oil as a lubricant with specific functions in the engine rather than a panacea for all operational ills. Engineering accuracy built into air and oil cleaners plus reasonable maintenance of these devices also will contribute to longer oil life.

REVEALS NEW HYDRAULIC UNITS for Bus-Truck Controls

BASED ON A PAPER* BY **G. W. PONTIUS**

Chief Engineer, Hydraulic Devices, Bendix Products Division
Bendix Aviation Corp.

RESULTS from testing hydraulically-operated equipment on a bus presage growing application of such systems to commercial vehicles. Among the vehicle components successfully controlled by hydraulic power are brakes, steering gear, windshield wipers, and doors.

Last year a 35-passenger transit-type bus was equipped with hydraulic devices for operation of all control functions. The system, a circuit diagram of which is shown in Fig. 1, operates at a maximum pressure of 1000 psi. While one bus control system is hardly adequate to predict service or maintenance problems, complete absence of trouble to date has whipped up much enthusiasm for hydraulic power.

The excellent performance of hydraulic power has already been demonstrated. It also offers other advantages . . . high efficiency, quick response, self lubrication, compactness, light weight, quiet operation, brief charging time, and minimum condensation.

Extensive hydraulic engineering demanded by complex military aircraft control stimulated much current interest in this form of control power. Basically, hydraulic components for aircraft and motor vehicles are the same. Both rely on principles proved through many years of industrial use.

The hydraulic units noted in Fig. 1 and described on the following two pages give some insight to the experimental activity recently undertaken in the automotive field.

■ A more complete discussion on these and other units in the experimental bus system will be available in SAE Quarterly Transactions where the paper, on which this article is based, will be published in full. - - - - - - - - - - - - - - - - - - →

* Paper "Hydraulic Devices for Commercial Vehicles," was presented at SAE Chicago Section, March 3, 1947.

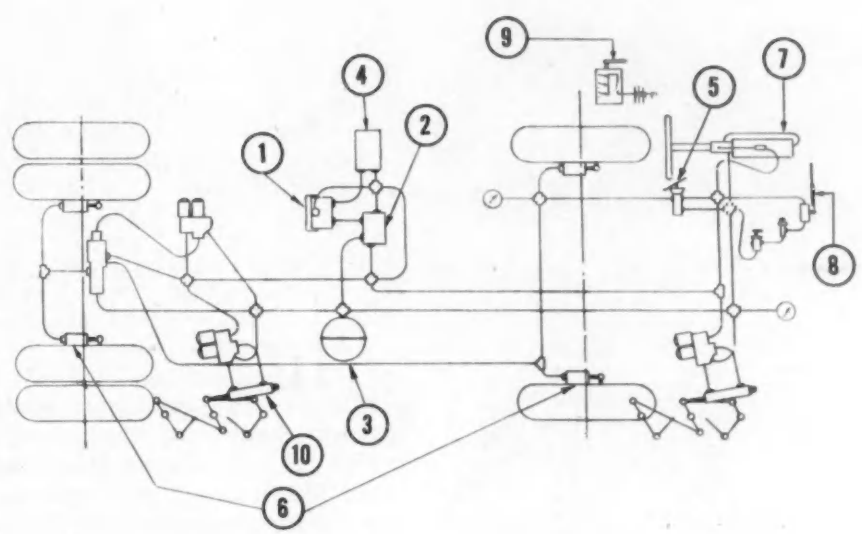
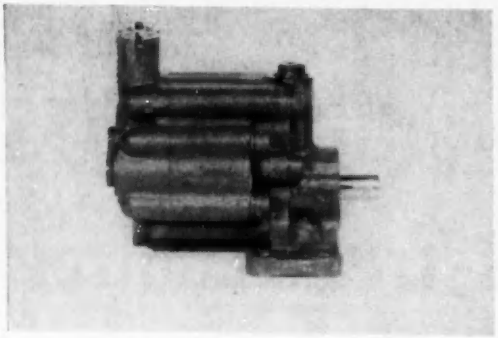


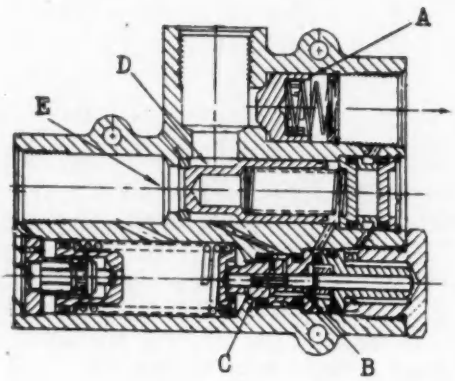
Fig. 1 – Schematic of hydraulic equipment system powering controls on a bus. Units are pump (1), regulator (2), accumulator (3), reservoir (4), brake control valve (5), brake operating cylinders (6), power steering gear (7), windshield wiper (8), door controller (9), and operating cylinder (10). These devices are described on the next two pages



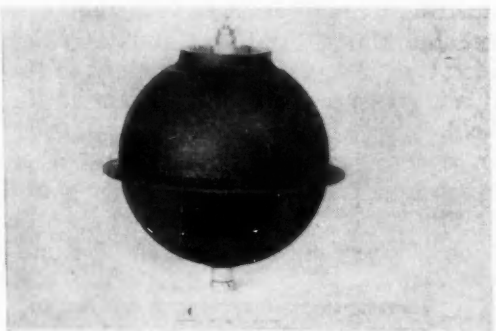
1. This 15-lb gear-type pump unit has a theoretical displacement of 1¼ in. per revolution and is driven at approximately engine crankshaft speed.

Installed within the rear end plate is a relief valve set somewhat above the normal pressure range, which is determined by the regulator valve, discussed below.

Overall pump efficiency varies from 70% at engine idling speed to 76% at 3000 rpm.

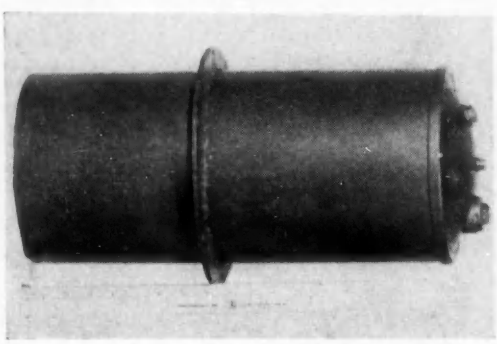


2. Pump-flow direction and pressure are determined by this regulator valve. In this position it directs oil through check valve "A" to the accumulator until maximum pressure is reached. Pilot valve "B" will have moved to the left, closing the high-pressure passage and opening low-pressure passage "C". Cut-off valve "D" will now open return port "E" and the check valve will seat, sealing the accumulator supply.



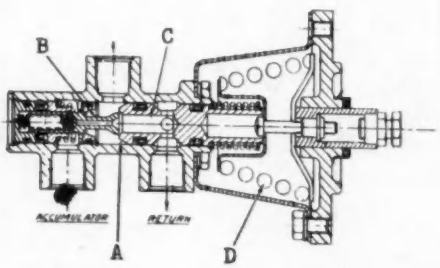
3. The accumulator is a 10-in. sphere weighing 20 lb. Its shell consists of two steel hemispheres welded together at the equator. An air inlet valve is provided at one pole and an oil supply port at the opposite pole.

Approximately 450 psi provides 56 cu in. discharge between the regulated range of 800 to 1000 psi. It's possible to make 9 to 36 brake applications if the pump supply fails, depending on slack adjustment.



4. Oil filter and reservoir combined weigh 23 lb. The two are built in one unit for economy; but they may be installed separately if desired or if installation space poses a problem.

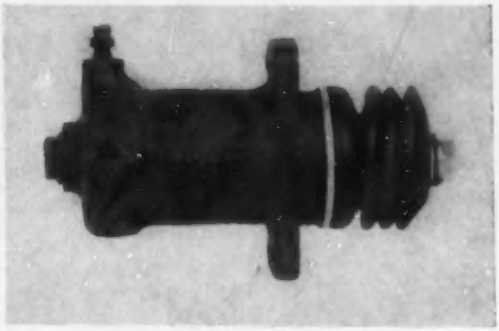
The filter mounting permits convenient removal for cleaning or replacement. Cartridge end plates are held in place by a compression spring which releases when the reservoir head is removed by loosening a cap screw.



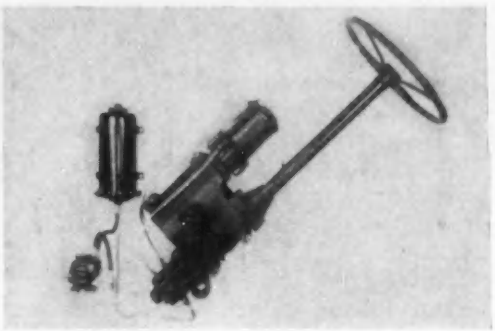
5. The brake control valve is shown in its released position. Depressing the treadle seats the normally-open valve "A", closing the return passage. Further movement opens inlet valve "B" and allows flow from accumulator to brake cylinder. Treadle reaction increases proportionately with pressure rise in the brake system. Difference in areas of return-valve plunger "C" determines this reaction. Spring "D" determines treadle position sense.

6. Brake cylinders are externally mounted and engaged to levers keyed to the brake camshaft in the conventional manner. On front brakes, cylinders of 1½-in. bore and 2-in. stroke are used. Rear-brake cylinders have a 2-in. bore and 2-in. stroke. This is a photograph of the rear cylinder, although both look alike.

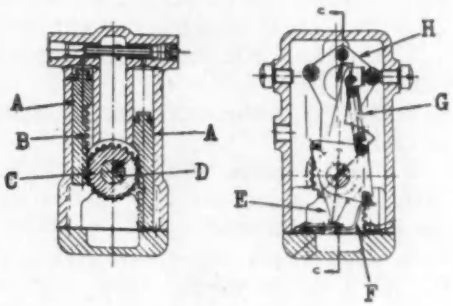
Time lag between treadle application and attainment of braking pressure in the line is 0.2 sec.



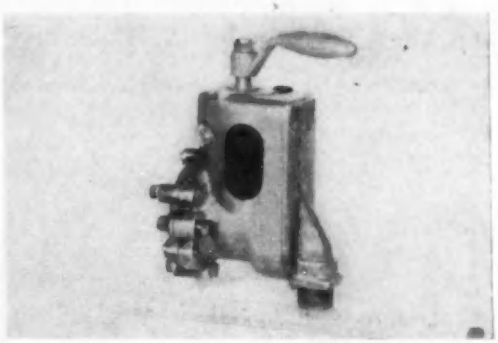
7. Power steering gears retain the desirable sensitivity and "feel" of the road and at the same time effectively absorb all objectionable impact so that none is transmitted to the driver's hands. In the heaviest vehicles there is no wheel "fight" when striking curbing or broken pavement. Complete control is maintained even with blow-outs of large tires. Power also improves steering speed. This experimental gear has a ratio of about 20:1.



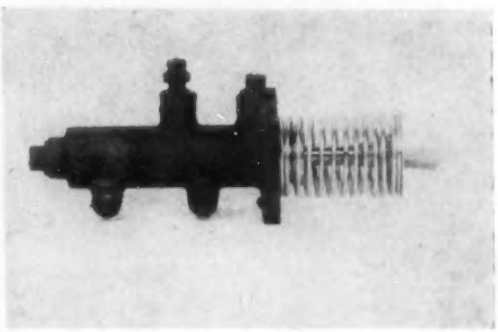
8. Mechanism of the windshield wiper motor consists of two pistons "A", each having integral rack "B" engaging pinion "C", keyed to the oscillating drive shaft "D". Also keyed to this shaft is trip-release plate "E" that contacts, at either end of travel, trip leaf spring "F" connected to over-center spring "G". The other end of this spring is fastened to valve-actuating lever "H". This motor weighs 2 lb, less the standard wiper blades.



9. Combining electrical control and hydraulic actuation in the door operating system simplifies plumbing. The controller shown consists of a three-piece housing construction to facilitate adjustment and replacement of switches. The unit is so designed that either the front or rear doors may be opened first. The dash-pot delay allows sufficient door-opening time for contingencies such as erratic operation.



10. The 1¼-lb master cylinder is mounted to the floor-board in a vertical position and connected to the treadle by a ball and socket joint. A compensating valve provides for expansion and contraction of hydraulic fluid with temperature variation. Open in the released position, the valve provides communication between reservoir and complete system. Depressing the plunger closes the valve and displaces oil into a slave cylinder.



Preignition Piston Failures in Single-Cyl

TESTS of both a CFR and a Wright G-200 single-cyl engine with excessive spark advance under high load and temperature conditions produced preignition-type failures and disclosed the mechanisms involved. This work showed that local peak piston temperature governs whether and where piston failure takes place. This temperature is determined by the general temperature level and temperature distribution on the piston and by the effects of local blowby and scuffing.

From the CFR engine test results the authors conclude that:

1. Large piston-cylinder clearances contribute to failure;

2. Compression ring gap alignment at a hot operating point on the piston crown perimeter accelerates failure;

3. Large ring-gap clearances accelerate failure, but to a minor degree compared to the first two causes;

4. Scuff bands, under the conditions used, do not affect the process of failure, and

5. Severe scuff marks on the piston surface greatly accelerated the failure.

From the Wright engine tests the authors conclude that:

a. Large overall piston-cylinder clearances, together with a ring-gap position of the top three compression rings between the piston thrust side and back, produced piston failures without injury to the exhaust valve;

b. Small overall piston-cylinder clearances, even with a ring-gap position of the top three compression rings between the piston thrust side and back, produced exhaust valve injury without injury to the piston;

c. Small piston skirt-cylinder clearances, even

EXCERPTS FROM A PAPER* BY

A. G. Cattaneo Head, Motor Laboratory

and E. P. Viscia Research Engineer

SHELL DEVELOPMENT CO.

*Paper "Piston Failure by Preignition and Detonation," was presented at SAE Northern California Section, San Francisco, Dec. 10, 1946.

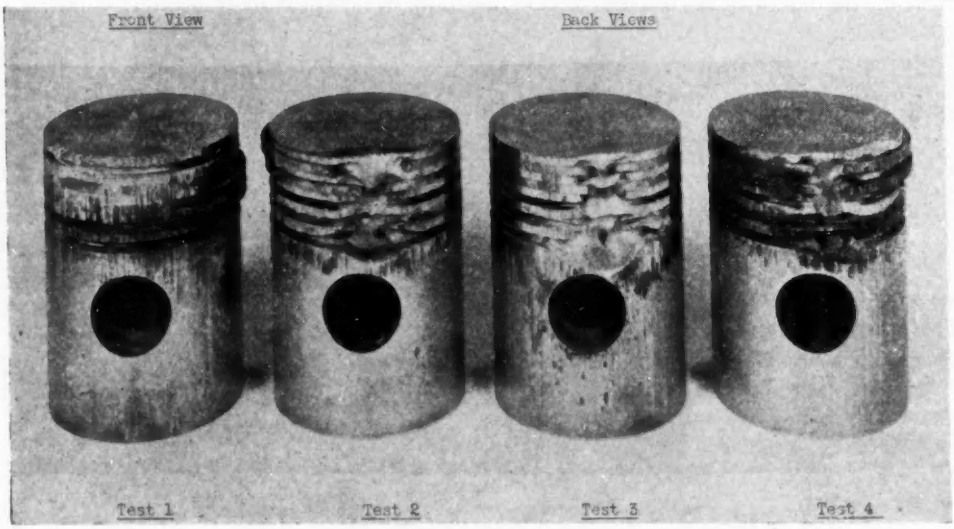


Fig. 1 – Piston failure occurred within 5 min test time after top ring removal. Failure could not be achieved under the same conditions with the CFR engine with the top ring installed. With the other pistons shown, all failures occurred at the piston back and at the position of the top-ring gap. Increase in piston-cylinder clearances decreased test time until failure

Diagnosed Tests

with large ring belt-cylinder clearances and the top three compression ring gaps between the piston thrust side and back, produced exhaust valve injury without injury to the piston, and

d. Top three compression-ring gap positions between the piston antithrust side and front, even with large overall piston-cylinder clearances, produced exhaust valve injury without injury to the piston.

Study of preignition failure mechanism stemmed from the occasional and sometimes epidemic failures that plague aircraft operators. While vaguely attributed to either detonation, preignition, or overheating of the piston, cause of these failures is never understood in detail. Reason for this is that very little time elapses between the beginning of the destructive mechanism and its termination by piston failure. This confronts the shop with evidence which permits no study of cause or intermediate mechanism.

In these laboratory tests[1] the piston failure could be produced or averted at will by adjustment of two blowby controlling factors – piston-cylinder clearance and ring-gap position. Data developed from these tests should aid in analyzing failure evidence in the field since other factors may have similar effects . . . ring sticking, scuffing due to foreign particles or faulty lubrication, or irregularities in the power or temperature control of the engine.

A laboratory test was developed with controlled initiation of the progress of destruction and the possibility of termination at any desired stage. Initial tests on the 3¼-in. bore CFR engine showed that preignition could best be simulated by advancing the spark excessively at normal high power loads. At the same time precautions had to be taken that the resultant high heat flow to all combustion chamber walls would not lead to overheating of spark-plug electrode or exhaust valve, causing uncontrolled preignition.

[1]Procedures for both tests are detailed in the preprint of the paper from which this article was excerpted.

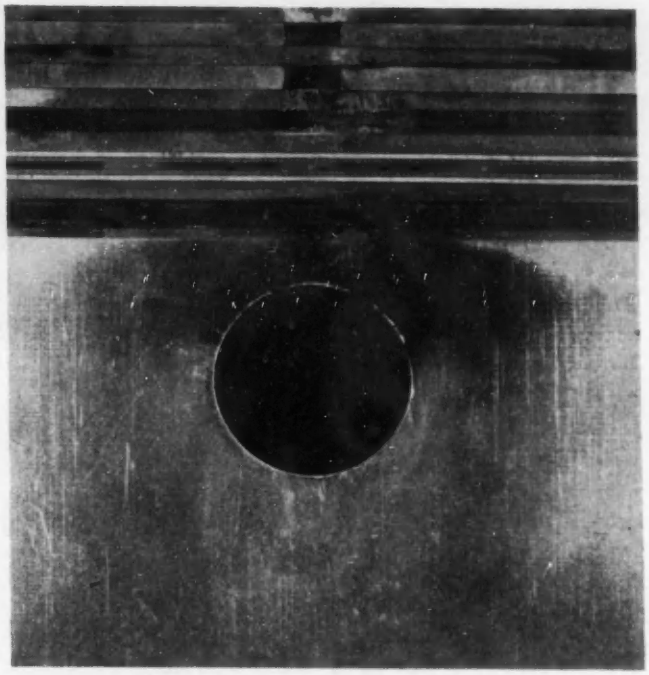


Fig. 2 – The piston was about to fail at the ring-gap position in this large piston-cylinder clearance test with ring gaps pinned at the piston front. Test time was 5 hr and 40 min. Now see Fig. 3

To further accelerate failure of the piston rather than that of other highly stressed parts, the top piston land was narrowed. This weakens the piston crown and relatively increases the thermal load on the ring belt. The bottom compression and oil rings were removed which decreases blowby control.

After completion of the study on the CFR engine, tests were carried over to a single-cylinder Wright G-200 engine. Here also excessive spark advance was used to simulate preignition. The much-less-rugged and more highly-stressed piston of this engine required no additional weakening or increase of thermal load.

CFR Engine Preignition Test Results

During development of the test method – conditions for which are given in Table 1 – the piston could not be failed at 90 deg spark advance while all rings were in place, even when the fuel-air ratio was varied over a wide range. However, when the top compression and bottom oil rings were removed, failure was obtained within 5 min.

Table 1 – CFR Engine Test Conditions

Engine speed	1800 rpm
Compression ratio	7.0
Jacket temperature	375 F
Inlet air temperature	225 F
Oil temperature	165 F
Oil pressure	65 psi
Spark advance	125 deg btdc
Fuel-air ratio	0.104
Manifold pressure	64 in. hg abs

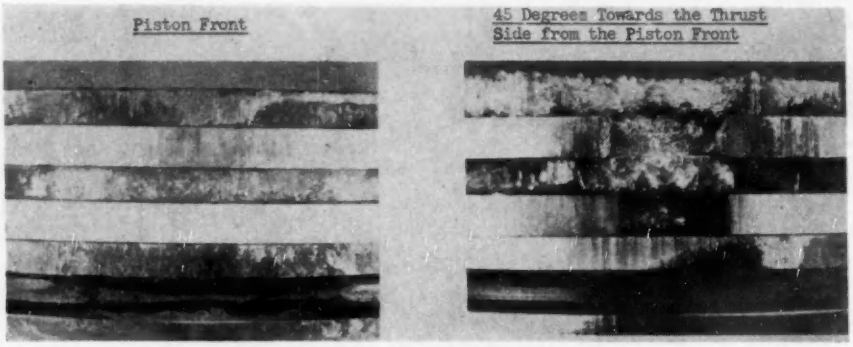


Fig. 3 – With the gaps in Fig. 2 moved 45 deg toward the thrust side from the piston front, the right-hand photograph shows the piston land failure produced after another 5 min testing. The failure at the ring-gap position in Fig. 2 appears healed, judging from the left-hand photograph

Fig. 1 shows the appearance of the failure, which is particularly interesting because of the lack of blowby evidence normally found on preignition failed pistons. The melting of the top ring land probably resulted from the high heat flow of simulated preignition which was enhanced by the heat dam formed by top ring removal.

To avoid the heat dam effect, the top ring was left in place for all later tests and added severity was sought by increase of the spark advance to 125 deg. The bottom oil and compression rings were removed to increase blowby under failure conditions and to facilitate its measurement.

Fig. 1 also shows the pistons from tests 2, 3 and 4 which failed under these conditions with unpinned rings. All three pistons had the same appearance. In each case the point of failure lay at the piston back, below the exhaust valve, and coincided with the position of the top ring gap. It also became evident from these preliminary tests that the amount of test time until failure decreased as the piston-cylinder clearance increased.

To test more closely the influence of ring-gap position, ring-gap width, and piston-cylinder clearance, tests were continued with controlled clearances and with the rings pinned against rotation. The data are given in Table 2 together with the time under test required to fail each piston.

Comparison of tests 5 and 6 (Table 2) clearly shows the considerable effect of the piston-cylinder clearance which may be attributed to the corresponding increase in blowby and general piston temperature. Comparative examination of tests 5 and 7 reveals the large effect of compression-ring gap positions which is ascribed to the increased blowby and local peak temperature.

To further test the influence of ring-gap position, test 7 was continued after 5 hours and 40 minutes test time (Fig. 2), with the gaps moved to a point 45 deg towards the thrust side from the front. Five minutes' additional test time produced a piston land failure at this point as shown in Fig. 3. The incipient failure at the former ring gap position had not progressed; in fact it had healed to a considerable extent.

(Small holes on the ring bearing and piston surfaces, shown in these and subsequent photographs, are points where ring pinning wires were inserted or where hardness tests were taken. Attempts to evaluate the temperature pattern by hardness tests were not successful, largely because the time of exposure to a high temperature varied so much between tests.)

Table 2 – Preignition Test Operating Variables and Failure Times

Test No.	Piston-Cylinder Clearance	Ring-Gap Clearance	Compression Ring-Gap Position	Failure Time	Remarks
5	Large	Large	Piston Back	4 min	
6	Small	Small	Piston Back	2 hr 30 min	
7	Large	Large	Piston Front	5 hr 45 min	Approximately the same clearances as used on test 5
8	Large	Medium	Piston Back	25 min	
9	Large	Small	Piston Back	15 min	
10	Large	Large	Piston Back	4 min	Scuff band piston
11	Small	Large	Piston Front	15 min	Piston scuffed at front and back

Note: All failures occured at compression ring gap positions. Piston-cylinder and ring gap clearance dimensions are shown in Table 3.

Table 3 – Clearance Dimensions, Compression Ring Gap Positions and Failure Times for CFR Preignition Failure Tests

	Piston Cylinder Clearances (Inches)						Ring Gap Clearances (Inches)						
	Transverse			Longitudinal							Failure Time		
Test No.	No. 1 Land	No. 5 Land	Skirt	No. 1 Land	No. 5 Land	Skirt	No. 1 Ring	No. 2 Ring	No. 4 Ring	Ring Gap Position	Hr	Min	Remarks
5	0.030	0.029	0.019	0.030	0.025	0.020	0.044	0.047	0.042	Piston Back		4	
6	0.020	0.011	0.010	0.020	0.010	0.009	0.020	0.020	0.019	Piston Back	2	30	
7	0.030	0.026	0.019	0.030	0.026	0.019	0.044	0.047	0.042	Piston Front	5	45	
8	0.032	0.026	0.020	0.030	0.025	0.021	0.025	0.025	0.021	Piston Back		25	
9	0.027	0.025	0.016	0.027	0.025	0.016	0.018	0.018	0.020	Piston Back		15	
10	0.030	0.025	0.021	0.030	0.024	0.021	0.048	0.048	0.048	Piston Back		4	Scuff band piston test
11	0.031	0.020	0.014	0.032	0.020	0.014	0.044	0.047	0.042	Piston Front		15	Scuffed piston test
12	0.021	0.018	0.011	0.021	0.018	0.012	0.018	0.018	0.020	Between piston front and antithrust side	6	40	Detonation test

Comparison of tests 5, 8, and 9 indicates only a slight effect of ring-gap clearance, large gaps promoting failure. The fact that test 8 with larger piston clearances gave a longer failure time than test 9 (Table 3) emphasizes that the effect is smaller than the reproducibility of the test procedure.

Scuff bands are 1/16-in. wide bands projecting from the piston top land to establish contact, under operating conditions, between the hottest part of the piston periphery and the cylinder walls. This should reduce the resistance in the heat flow path and result in lower general temperature levels on the piston.

The ease with which failure was produced in test 10 on such a piston indicates little value for these scuff bands as a preventive against preignition piston failure.

In the course of the tests one cylinder was found which consistently scuffed pistons, probably because of distortion. Since scuffing caused by cylinder distortion or other factors is a frequent occurence in field operations, one of these scuffed pistons that was not otherwise damaged was subjected to a preignition failure test in this same cylinder.

Fig. 4 shows photographs of the piston before and after completion of test 11. Obviously the ring gap has again exerted its effect on the point of failure. Comparison of this test 11 with test 7 (Table 2) shows that the scuffed condition of the piston has greatly accelerated the failure which can be ascribed to high blowby and heat flow.

A photograph of the characteristic appearance of the cylinder after a piston failure is shown in Fig. 5. Metal bonding and burning was always found on the side corresponding to the piston failure area.

CFR Engine Detonation Test Results

If the failure appearance of the detonation-failed piston in Fig. 6 is compared with the preignition-

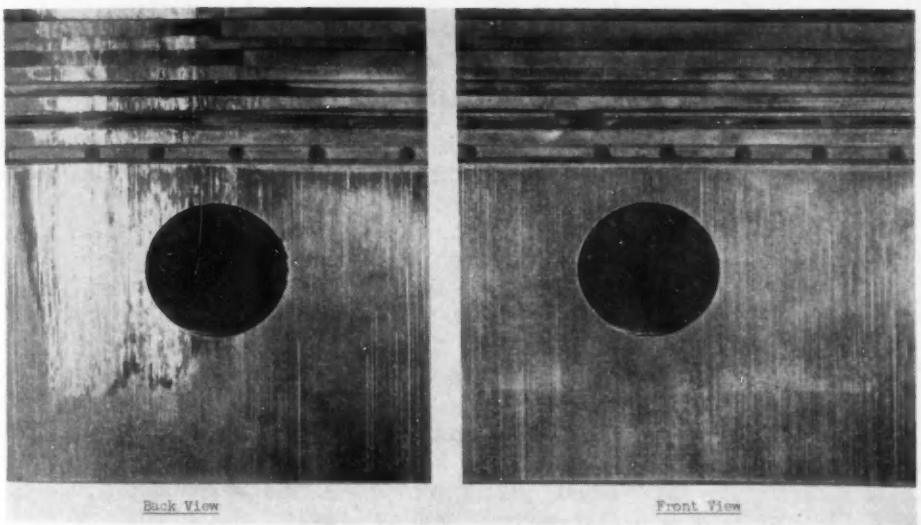
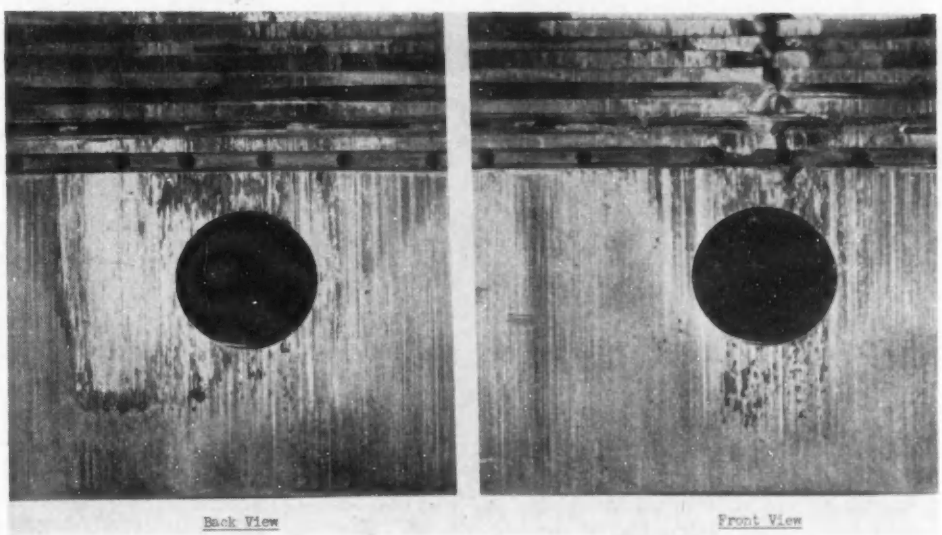


Fig. 4 – Piston used in scuff test 11 before the test is shown at left and the failure after 15 min of testing is shown below



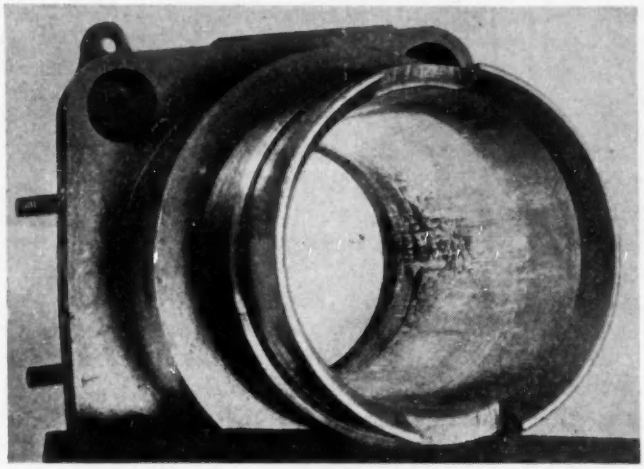


Fig. 5 – Characteristic CFR sleeve appearance after piston failure

failed pistons in Fig. 1, the dissimilarity is clearly evident. The detonation failure test was operated under the conditions of Table 1, except that the spark advance was 45 deg before top dead center. The manifold pressure (64 in. hg abs.) was 16 in. hg above incipient detonation for the fuel and conditions used.

It was necessary to dispense with the removal of piston crown metal for this test since that led to top land breaking before the surface of the

Fig. 6 – Detonation-failed piston after 6 hr and 40 min testing. The piston-cylinder clearances were small and the ring gaps were pinned in the position shown

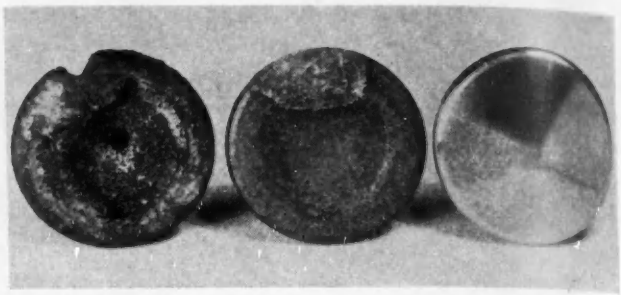


Fig. 7 – Wright G-200 failed, caved, and normal exhaust valve heads

piston metal showed signs of injury. Table 3 shows clearances and ring gap position. The failure time was 6 hr. 40 min.

Although blowby became excessive as failure neared, no blowby injury in the ring belt area is found. This, together with the top land breaking mentioned, indicates that the detonation failure was of a mechanical (hammer blow) nature and not associated with a high general temperature level of the piston.

Wright Engine Preignition Test Results

To confirm the influence of piston-cylinder clearances and ring gap position previously found on the CFR engine, tests on the Wright G-200 single-cylinder engine were also run with controlled clearances and ring gaps pinned against rotation, under conditions shown in Table 4. The data are given in Table 5 together with the time under test needed to fail the piston or to injure the exhaust valve.

Comparing tests 2-C and 7-C with the other tests (Table 5) clearly shows that during these tests exhaust valve failure or injury occurred before piston failure, except when the overall piston clearances were large and the compression ring gaps pinned between the piston thrust side and back. Fig. 8 represents the relationship between the piston, valves, spark plugs and oil spray nozzles.

Fig. 9 presents a side by side photograph of tests 2-C and 7-C pistons after failure, showing the exceptional similarity in appearances. This, when the identical test times and operating conditions are considered, indicates the good reproducibility of these tests.

On Preignition Failure Mechanism

Preignition, an abnormally early ignition of the air-fuel mixture, leads to a very inefficient combustion cycle. Of the heat energy released, only a smaller fraction is converted to mechanical power and heat rejection to the combustion chamber walls is correspondingly increased. At the same time the combustion pressure is present over a larger part of the compression stroke. This increases the quantity of blowby gases passing through the piston-cylinder clearance per cycle.

Increased blowby (test 12) without the added heat flow from early ignition did not give a failure of preignition appearance. It appears, therefore, that the temperature rise due to increased blowby is not of a run-away nature and does not by itself lead to destruction. On the other hand the increased heat flow alone will destroy the piston. But in this type of failure (test 1) the top land melts, while the lower rings and piston areas show no damage incurred prior to the moment of final failure.

In between these extremes lies the range where a weakening of the piston material through preignition heat flow is accelerated by increased blowby. The latter acts either by direct heating of the piston side, or by destroying the lubricant film and permitting scuffing of cylinder and piston metal.

Table 4 – Wright G-200 Engine Test Conditions

Engine speed	2200 rpm
Compression ratio	6.18
Rear spark plug gasket temperature	400 to 450 F
Inlet air temperature	150 F
Inlet oil temperature	185 F
Outlet oil temperature	225 F
Oil pressure	40 psi
Front plug spark advance	20 deg btdc
Rear plug spark advance	128 deg btdc
Fuel-air ratio	0.100
Manifold pressure	44 in. hg abs

Table 5 – Clearance Dimensions, Compression Ring Gap Positions and Failure Times for Wright Engine Preignition Failure Tests

Test No.	Piston-Cylinder Clearance, inches: No. 1 Land	No. 3 Land	Skirt	Top Three Ring Gap Positions Between	Failure Test Time	Remarks
2-C	0.066	0.052	0.039	Thrust side and back	1 hr 0 min	Piston failed at the ring gaps
3-C	0.049	0.036	0.027	Anti-thrust side and front	2 hr 30 min	Exhaust valve failed (Fig. 7)
4-C	0.049	0.037	0.026	Thrust side and back	2 hr 10 min	Exhaust valve caved (Fig. 7)
5-C	0.065	0.053	0.027	Anti-thrust side and front	1 hr 0 min	Test discontinued to run test 6-C
6-C	0.065	0.053	0.025	Thrust side and back	1 hr 30 min	Exhaust valve caved as in test 4-C
7-C	0.066	0.055	0.039	Thrust side and back	1 hr 0 min	Piston failed at the ring gaps
8-C	0.070	0.056	0.041	Anti-thrust side and front	3 hr 15 min	2 Exhaust valves caved as in test 4-C

Note: Exhaust valves in tests 2-C and 7-C appeared in good condition after piston failure. Photographs of a failed, injured and normal exhaust valve are presented in Fig. 7.

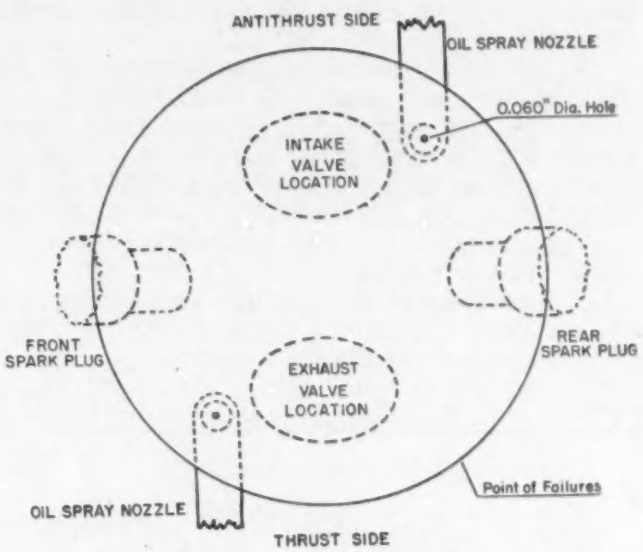


Fig. 8 – Schematic diagram of the Wright G-200 single-cylinder engine piston and accessories

This effect of increased blowby was locally obtained in the tests by alignment of ring gaps. The failure promoting effect of large piston-cylinder clearance (test 5) and prior scuff marks (test 11) may also be attributed to somewhat increased blowby.

In test 6 the effect of ring gap blowby was accompanied by a considerable amount of ring and skirt scuffing, probably from a combination of close piston-cylinder clearances and local peak temperatures. This scuffing contrasts with a lack of scuffing on the large-clearance test-piston.

All the CFR preignition failures that occurred at the back of the piston, below the exhaust valve, were identical in appearance to the three failures at that point shown in Fig. 1. It should be pointed out that while the "scuffed" piston failure appearance (Fig. 4) was also similar to the others, the test 7 piston front failure was much less severe.

Fig. 9 – Both of the Wright G-200 pistons (test 2-C left and test 7-C right) failed at the ring-gap position under identical operating conditions after 1 hr test time. The gap is between the thrust side, left, and the back of the piston, right

In every case the appearance was distinctly different from that of the detonation-failed piston (Fig. 6).

The heat flow from the combustion chamber to the piston is not evenly distributed across the piston. Failure is therefore obtained much more rapidly for one position of the aligned compression ring gaps than for another. On the Wright engine tests this is exhibited by increased ring scuffing, independent of ring gap position, between the thrust side and back.

In aircraft engine field practice today rings are free to rotate around the piston unless they are held by groove deposits. The rotation is of the order of < 5 rpm, and its speed and direction vary from ring to ring. Ring gaps do therefore align quite frequently, and use of the alignment for test purposes may be well justified.

It would seem that prevention of the effect of alignment or, even better, prevention of blowby passing through individual gaps will decrease the chance of damage for a given degree of preignition severity. Unfortunately field preignition usually caused by overheating of a specific combustion chamber part is a self accelerating phenomenon, and the ultimate rejected heat flow will be so large as to lead to destruction regardless of all other factors.

CORRECTION — J. A. WATTS MISQUOTED

In the article "Fitting Off-the-Road Vehicles to the Job," by H. L. Rittenhouse, pp. 40-41, of the September, 1947, SAE Journal, the discussion on transmissions by J. A. Watts was erroneously digested. First paragraph of the discussion should have referred to off-the-highway requirements instead of off-the-highway service. And Watts favors as many ratios or speeds as practicable rather than the four and five-speed transmissions indicated. His full discussion is as follows:

I am sure we all agree that Mr. Rittenhouse shows a broad knowledge of off-the-highway equipment and has presented the salient points for our edification.

It seems that a question should be raised regarding transmission requirements in the interest of increasing vehicle performance and making maximum use of the engine. In off-the-highway requirements, the ratio of unused horsepower to the maximum available horsepower is unity, especially during the loaded trip. Under "Units Steered by the Driving Axle" this statement appears: "since speeds are a maximum of 15 mph the cost and weight can be kept down by using a four-speed transmission which is adequate." Later, under "Units Steered by Positive Steering" this statement appears: "in designing for higher speeds, larger transmissions are required to get at least five speeds."

The speed droop between available gears represents a horsepower loss over that potentially available if we had a means of perfect torque conversion. That is, in a given gear as the load conditions meet and overcome the available maximum horsepower at governed speed, the engine speed reduces and the available horsepower output reduces along with a reduction in vehicle speed. Now the ideal would be to have available a gear ratio which would allow reaching governed speed for obtaining maximum vehicle speed and maximum engine horsepower output to meet the load, grade and rolling resistance encountered. Percentage wise it makes no difference whether the vehicle is designed for a maximum speed of 15 or 50 mph. A drop of 800 rpm in engine speed brings about the same reduction in horsepower irrespective of the top vehicle speed. Again percentage wise the vehicle speed loss or trips per hour is correspondingly reduced. From a practical standpoint a workable compromise has not been achieved because of –

1. Space limitations.
2. Suitable combinations of ratios or shifting progression.
3. Lack of general appreciation of the problem and its practical usage.
4. Cost – the consideration of this problem is equally important for all types of motive-power, whether using gasoline, Butane or fuel oil.

It is true, as mentioned, that the diesel "has the ability to produce high torque at comparatively low engine speed." A rising torque characteristic is advantageous and means an improvement in horsepower output per 100 rpm (or unit adopted) reduction in engine speed under full throttle and the kind of operations we are discussing use full throttle much of the time. However, since the rate of overcoming the vehicle resistance is as important as the ability to overcome the resistance, one is forced to think and evaluate in terms of horsepower.

One usage not specifically mentioned is the use of pneumatic tired equipment for underground operation. The diesel has a natural advantage for this type of work, because of the exhaust gas characteristics as well as the cost of moving material. At the moment there is no unanimity between local and Federal mine safety bodies regarding safety requirements. However, the increasing operator demand is gradually bringing forth a code.

Engine mounting and arrangements for accessory equipment present a real problem. As mentioned in the paper, electrical operation of the steering for two wheel units is in use. Furnishing hydraulic pump drives for steering seemed a problem, but the arrangements for a large generator become even more involved from the physical location and torsional standpoint.

Engineering the WORLD'S FASTEST CAR

BASED ON A PAPER* BY

REID A. RAILTON

CONSULTING ENGINEER

THE world speed record of 394.196 mph set by John Cobb on Sept. 17 at the Bonneville Salt Flats, Utah, in the Railton-designed car proved the validity of new high-speed concepts disclosed for the first time by Railton at the 1947 SAE Annual Meeting eleven months ago. He brought out that:

Much - overlooked in current discussions of streamlining to improve performance are its secondary effects. Because they influence car handling, these secondary effects are acutely important to racing car design and will need consideration when and if streamlined cars are offered to the public.

Effect on Maneuverability

Achieving low wind resistance often increases overall car length because of the added nose and tail. This additional weight makes for maximum increase in the vehicle's polar moment of inertia. While it may help the suspension problem, the increase plays havoc with steerability. For this reason extremes in streamlining are seldom attempted on road or track race cars.

Some streamlined bodies also behave peculiarly in a side-wind. Aerodynamically, side-wind on a car parallels yaw on aircraft. But while airplane stability depends on position of the center of pressure relative to the center of gravity, criterion of car stability is the center of pressure position with regard to the rear axle.

Therefore, no practicable car – streamlined or not – can be aerodynamically stable from a steering standpoint since the center of pressure will always be well forward of the rear axle. Stability in this sense would be just as objectionable as instability. Somewhere between the two lies the desired condition. Unfortunately good streamlined body shapes greatly exaggerate this instability; for small yaw angles their centers of pressure are so far forward, sometimes even in front of the nose.

Improved acceleration resulting from reduced aerodynamic drag is another factor not receiving the attention it merits. In pleasure cars, increased acceleration is the most noticeable effect of a streamlined body. If streamlining alone boosts top car speed from 90 to 100 mph, then acceleration from 70 to 80 mph is increased 25 to 30%. This is a more valuable feature than the 11% increase in ultimate speed.

Problem here is the cost of achieving this degree

*Paper "Odd Problems at High Speeds," was presented at SAE Annual Meeting, Detroit, Jan. 6, 1947.

Nature's Salt "Track" Preempts Speed Records

Practically all the world's automobile speed records – from 1 km to 24 hr – were made at Utah's Bonneville Salt Flats because it satisfies three essential requirements unobtainable anywhere else.

• First, long-distance record attempts require a track where speed can be maintained continuously without slowing down for curves. The 10 to 12½-mile circuits on the salt beds cannot be laid out at any other place in the world for present record speeds.

• Second, sprints for the world's land speed record must be run on a truly level surface to realize any degree of safety. If a surveyor ran an elevation check of the salt beds, he would find no variation greater than 2 in. in 1000 ft. Although the salt surface is rough in many spots, surface irregularities are unimportant. No known man-made road approaches it in necessary length, straightness, and absolute levelness.

• Third reason why the salt surface makes a good race track is its natural kindness to tires. The track surface "wears" more than the tires since the salt crystals are more easily pulverized than sand particles in cement.

Despite these advantages, the salt surface is far from ideal in other respects. It is honeycombed with soft spots. And most of the year a 2 or 3-in. layer of water submerges it. Only between July and November can it be used. Even then the water table is often 2 or 3 in. below the surface and may rise suddenly for no apparent reason.

Hot sun following a cold night expands the salt, displacing some of the water which then rises to the surface. Both for this reason and because of lower air temperature all short record attempts are made shortly after dawn.

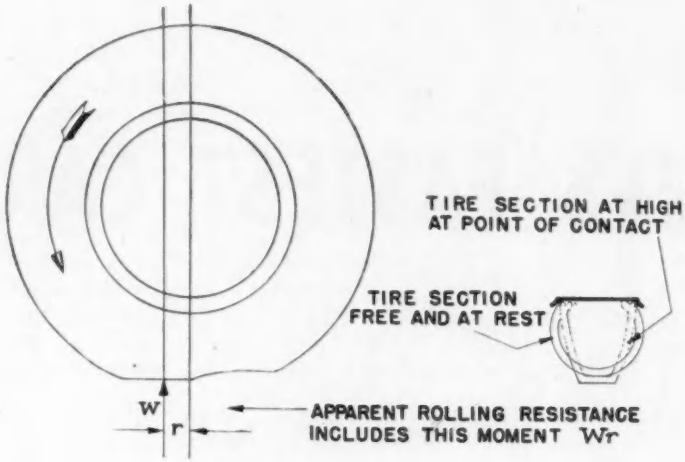


Fig. 1 – Exaggerated view of probable ground contact at high speeds with low inflation pressure. This shows why maximum inflation pressure lowers rolling resistance

of streamlining without adding weight that will reduce the gain in acceleration.

Take-Off Tendencies Clarified

Popular belief that a completely streamlined car may start flying at any moment stands out as fanciful fiction under factual examination. True, any body shape can be considered as a rather inefficient air foil. But model tests in a wind tunnel will reveal the angle of attack for zero lift. Any competent designer will determine this attitude and faithfully reproduce it in the actual car. He will also know how much the angle of attack can be increased before aerodynamic lift overcomes the force of gravity. This safe movement can be expressed in inches of vertical movement of the nose.

For example, maximum safe vertical movement of the nose of the Cobb car is about 12 in. Since it has been determined that maximum possible movement on the salt-bed course is about 3 in., the margin of safety is adequate. Of course some mechanical failure might change the picture; but at six miles per minute the result would be disastrous in any case.

Directional Stability

For many years it was fashionable for world-record cars to wear tail fins. While Railton put one on Sir Malcolm Campbell's Blue Bird, he has long been convinced that even if they do no harm, they are not much good.

The two results hoped for with fins are (1) directional stability and (2) prevention of spinning in a bad skid.

Investigation shows true directional stability – absolute self-steering – to be unattainable in practice. To achieve it the fin would have to be so large and so far back as to bring the center of pressure behind the rear axle for all yaw angles. Experiment shows this to be structurally impractical. And strong side-winds acting on a fin area designed to deal with even small angles of yaw would make it difficult to keep the car on its course.

A large though practical fin may reduce spinning tendency after a skid. But it's highly improbable that the driver could regain control in time to do much good. Certainly this dubious advantage is not worth such added weight and bulk.

Surprisingly little is known of either the nature or the amount of rolling resistance at high speeds. Combined aerodynamic drag and rolling resistance can be assessed from car performance, but separating the two is a problem. Forecasting them in the design stage is yet more difficult.

We do know that rolling resistance of a tire on the point of disintegrating, due to excessive speed and load, increases enormously. It's also known that going to maximum inflation pressure the material can take minimizes both disintegrating tendencies and rolling resistance.

Fundamental cause of both phenomena is probably a change in conditions at the point of contact with the road. This occurs when centrifugal forces on the tire fabric become large in comparison to inflation pressure forces. See Fig. 1. These centrifugal forces correspond to accelerations ranging between 5000 and 6000 g. At these speeds the ordinary Schrader valve head weighs several pounds. Even the valve spring becomes compressed solid by its own weight.

The 44-in. tires used on the Cobb car will support a load of nearly a ton and transmit about 600 hp each at 3000 rpm. Tire carcass consists entirely of the cord structure. The rubber "tread" is merely a thin waterproof covering. Inflation pressures are very high for the reasons given. No tire is ever used twice so that its minimum required life is 12 miles.

Cobb's car has four-wheel drive to keep propulsive effort per wheel as low as possible. This increases the margin of adhesion available for lateral control. Fig. 2 further illustrates the point. Weight is so low and aerodynamic drag so high that, with rear-wheel drive alone, the car would be dangerously near wheel slip.

Independent Suspension Merits

Almost all racing cars feature independent four-wheel suspensions to avoid periodic oscillation of the road wheels. This is why:

Acceleration, road-holding, and braking are all

dependent on adhesion of the tires. But bouncing tendencies of pneumatic tires impair adhesion; rigidly connecting such a wheel to its mate – as by conventional axle beam – transmits bouncing movement from one wheel to the other and lessens adhesion just when it is most needed. The independent suspension removes this link, allowing the wheels to bounce independently. The net adhesion then follows the law of averages.

While this explanation oversimplifies the problem, it conveys some notion as to why all-around independent suspension enormously improves race-car handling. It has real application to pleasure cars. A less-than-satisfactory feature of the modern automobile is difficulty of controlling and braking it on a "washboard" road surface at about 70 mph. Only complete solution to control of bounce with solid rear axle without interfering with ride smoothness lies in independently-sprung rear wheels.

On Presaging Results

Fourteen years ago Railton wrote a paper on forecasting performance and he admits that he hasn't learned much since. It's fairly simple to make an accurate model, wind-tunnel test it, and measure the drag. Following through with a little arithmetic will tell the theoretical horsepower required to propel the prototype at any given speed.

The last step is the stumper – finding the variation between the calculated figure and the actual power which will be needed.

Many factors influence this difference between theoretical and actual speeds, most important of which are the following:

1. Inability to reach true ultimate speed due to lack of distance to accelerate in;
2. Rolling resistance of the tires;
3. Variations in engine performance stemming from unavoidable differences between test-stand and race-track conditions;
4. Difference in Reynolds Number between wind-tunnel and full-scale conditions;
5. Inability to reproduce accurately on the model the aerodynamic conditions where tires contact the track;
6. Aerodynamic wheel-spinning losses;
7. Direction and amount of side-wind;
8. Mechanical efficiency of components such as transmission and axle, and
9. The normal experimental error of the model test.

Most of these factors are negligible at 100-mph speeds and a forecast can be made with some confidence. But at very high speeds the sum of these factors can easily exceed aerodynamic drag. Any attempt to evaluate and predict them would take more time and money than are usually available. In practice any forecast is an intelligent guess based on previous experience and spiced with generous allowances.

By way of illustration Railton compiled data on all the world's record cars for the last 20 years, dividing thrust theoretically available from their engines by the theoretical drag deduced from their model tests. The average resultant – which represents the ratio of actually-available to theoretically-required horsepower – works out to well over two. In other words, the horsepower actually used was more than twice what might have been deemed necessary from model tests alone.

The inevitable question put to the racing car designer in 1947 is, "What are the possibilities of jet propulsion for record-breaking racers?" The answer: Great.

The car would still be subject to limitations imposed by the length of track and by tire considerations. But the problem is primarily an aerodynamic one.

At the risk of confessing himself a reactionary, Railton feels that use of jet-propelled cars for land speed records would remove the last vestiges of resemblance to the commercial automobile. It would deprive these adventures of all engineering value and make the records themselves meaningless. For the same reason it would discourage financial cooperation from industry which alone makes these attempts possible.

With such cars developed to travel faster and faster, degree of contact with the ground will be no longer necessary for traction. It will be regarded as a nuisance and most of the weight will be airborne. Carried to its ridiculous extreme, nothing will stop a man from claiming the world speed record by running a roller skate tied to a fast airplane over the measured mile.

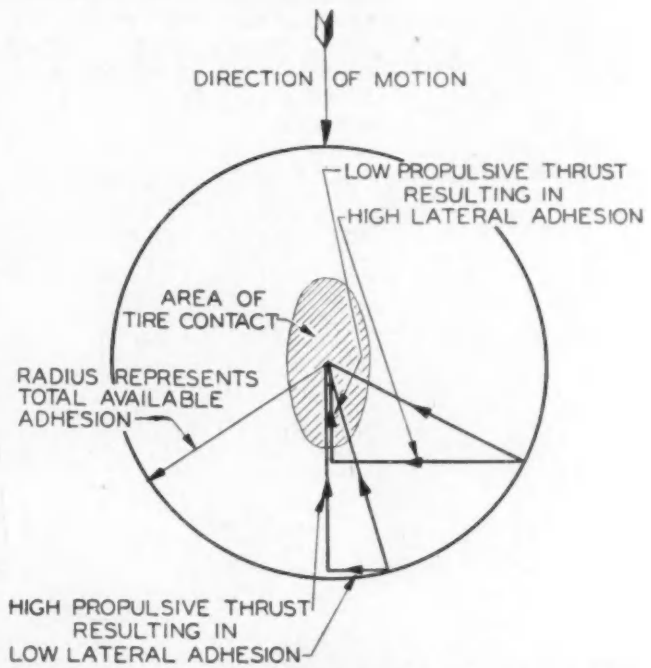

DIRECTION OF MOTION
LOW PROPULSIVE THRUST RESULTING IN HIGH LATERAL ADHESION
AREA OF TIRE CONTACT
RADIUS REPRESENTS TOTAL AVAILABLE ADHESION
HIGH PROPULSIVE THRUST RESULTING IN LOW LATERAL ADHESION

Fig. 2 – Represented here are the lateral forces between road and tire on the verge of wheel slip. It illustrates the reason for Cobb's car's four-wheel drive to minimize propulsive effort per wheel

GEORGE W. CODRINGTON, left, being congratulated by Secretary of the Navy JOHN L. SULLIVAN, after receiving the President's Certificate of Merit for outstanding service in directing the production of Diesel engine equipment used by Navy ships and submarines during the war. Codrington is vice-president of General Motors Corp., general manager of the Cleveland Diesel Engine Division, and president of the National Association of Engine & Boat Mfrs., Inc.

About

CHARLES A. BARESCH is now associated with Reaction Motors, Inc., Dover, N. J. He is chief design engineer.

W. W. DAVIES, chairman of the Chicago Section and SAE vice-presidential nominee for Air Transport Activity, addressed the luncheon session of the Third National Conference on Industrial Hydraulics Oct. 16 in Chicago. The director of engineering of United Airlines spoke of the SAE technical work in this area. Among the other speakers were **RAYMON BOWERS,** International Harvester Co.; **W. F. SHURTS,** Twin Disc Clutch Co.; **ROBERT LAPSLEY,** Clark Equipment Co.; **R. H. HENSLEIGH,** consulting engineer; and **PROF. J. I. CLOWER,** University of Delaware.

CHESTER M. METRA is now sales representative in Eastern Kentucky for Sheppard & Bogie of Lexington, Ky. Before this, he was parts & stores representative for the St. Louis regional office of the Electro-Motive Division of GMC. He had also been parts manager of the "Train of Tomorrow" for General Motors.

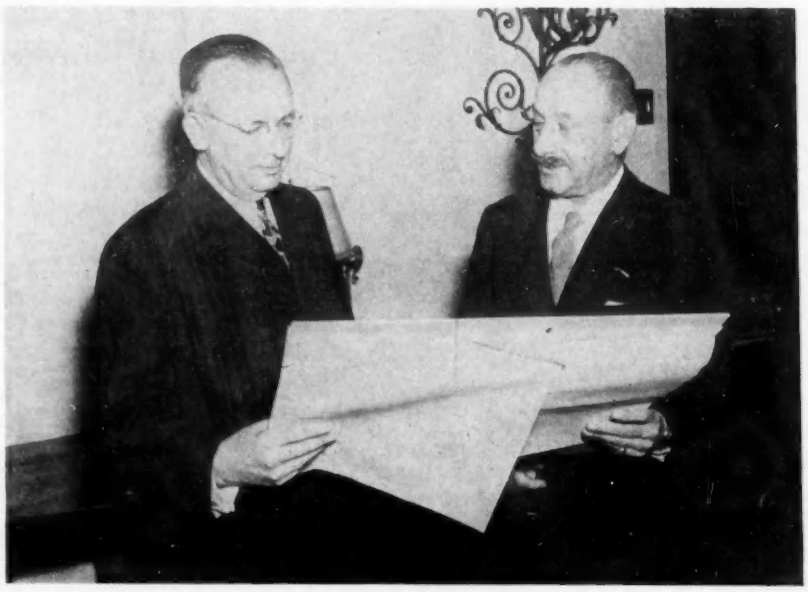
KARL D. WOOD, head of the Department of Aeronautical Engineering at the University of Colorado, has just published the eighth edition of his "Airplane Design." This edition features data on the new NACA low-drag airfoils and on the layout of helicopters and jet-propelled aircraft. The book shows how an airplane can be designed and includes in appendix form most of the data necessary for a student to carry a design project through its preliminary stages. About 30% of the text and 80% of the technical-data appendices are new.

Prior to taking his present job as tool designer for the Pioneer Engineering & Mfg. Co. in Detroit, **JACKSON H. ALLINGTON** was affiliated with the Graham-Paige Farm Equipment Division of the Kaiser-Frazer Corp. in Willow Run, Mich.

PAUL E. SPEISER recently joined the West Bend Aluminum Co. in Hartford, Wis., as a project engineer. Prior to this he was in the Armed Forces.

Recently becoming supervisor of field test and design engineers for Cummins Engine Co., Inc., in Columbus, Ind., **ALBERT C. BELL** had previously been a designer for this company.

OLIVER FIELD ALLEN'S "The Modern Diesel," a book for general reading and classroom use, has been published by Prentice-Hall, Inc. The book covers the background and history of diesel engines from Carnot's early theorizing right up to the diesels used today for marine, highway, rail, and stationary service. One chapter is devoted to the evolution of the 2-stroke-cycle engine from the 4-stroke-cycle engine. Others deal with double-acting diesels, sleeve-valve engines, and opposed-piston and free-floating-piston engines. The author tells much of his story in pictures and diagrams.



NAVY GROUP HONORS GM

On behalf of General Motors Corp., **C. L. McCUEN** received the first annual Distinguished Service Award presented by **REAR ADM. LUIS de FLOREZ,** U. S. N. R. for the Special Devices Association, Inc. The award was presented to General Motors in recognition of "the outstanding accomplishment in its scientific programs involving rapid learning techniques and mass training," on Sept. 20 at Sands Point, L. I., N. Y., during the three-day meeting of the Association. The group is composed of U. S. Navy reserve officers and civilians who have served in the Special Devices Center of Naval Research.

Members

Before joining the Tasco Corp., Dallas, Texas, as production manager, **JOHN G. WHITEHEAD** was general manager of the Industrial Hard Chromium Co. in Newark, N. J.

BURTON RICH MILLER recently accepted the post of assistant professor at Notre Dame University, Notre Dame, Ind. He will give air conditioning, heating, and ventilation courses. Before this he was senior mechanical engineer for Sverdrup & Parcel in St. Louis.

GEORGE ROMNEY of Detroit, who is managing director of the Automobile Manufacturers' Association, Detroit, has been appointed by Governor Sigler of Michigan to the new State Economic Development Commission which is taking over the duties of the State Planning Commission. He will serve for a one-year term.

JOHN S. CARR, who was recently graduated from the Illinois Institute of Technology in Chicago, is now connected with the Detroit Ball Bearing Co. of Michigan as a field engineer.

ALLEN L. BROWNLEE, former chief engineer of the Wico Electric Co., West Springfield, Mass., has been elected vice-president in charge of engineering by the directors of this company. He graduated from Worcester Polytechnic Institute and has been associated with Wico since 1942.

Preceding his appointment as associate professor of mechanical engineering at the University of Illinois in Urbana, **WILLIAM L. HULL** held this position with the University of Colorado in Boulder.

Now general metal shop teacher at the Compton Union High School District, Compton, Calif., **WALTER VAN VOORHEES** had been affiliated with Wickes Bros. Machine Tool Co. in Saginaw, Mich.

Formerly with Continental Motors Corp., Detroit, **MORRIS G. AVERY** is now a dynamometer engineer with REO Motors, Inc., Lansing, Mich.

No longer transportation superintendent for the Creameries of America, Los Angeles, **JOHN B. CLARK** has become owner of John Clark's Greenfield Truck Terminal in Bakersfield, Calif. In 1945 he served as T & M Vice-Chairman of the Southern California Section.

Recently graduated from Fenn College, Cleveland, **ROBERT K. WOODWORTH** is now a student engineer for the American Telegraph & Telephone Co. in Cleveland.

Now with the General Engineering & Research Corp., Trenton, N. J. as a mechanical engineer, **PIERCE HOLLINGSWORTH** had been detail draftsman for the Packard Motor Car Co. in Toledo, Ohio.

JOHN G. HAMMOND is now director of merchandising for Super Six Mfg. Inc. in Minneapolis, Minn. He was formerly manager of the Detroit Branch of the Elco Lubricant Corp. His new company manufactures agricultural implements.

Now employed as general manager of the Parts & Accessories Division, Sterrett Motor Service, Inc., Silver Spring, Md., **CLARENCE H. RAUSCHENBERG** had been on the British Army Staff, Royal Electrical & Mechanical Engineers, Washington, D. C.

Now in the employ of the Fairchild Engine & Airplane Corp., Oak Ridge, Tenn., **CHADWICK S. DAUWALTER** had been design engineer for the Rocket Engineering Co. in Los Angeles.

Heretofore connected with Luke Harris Industries, Inc. in Willow Run, Mich., **LUKE HARRIS** has become vice-president in charge of sales and a member of the Board of Directors of the Lockheed Aircraft Service, Inc. in Burbank, Calif.

SEYMOUR EPSTEIN is now an instructor of Design at Brooklyn College in Brooklyn, N. Y. Prior to this, he was an instructor of physics at Mohawk College in Utica, N. Y.

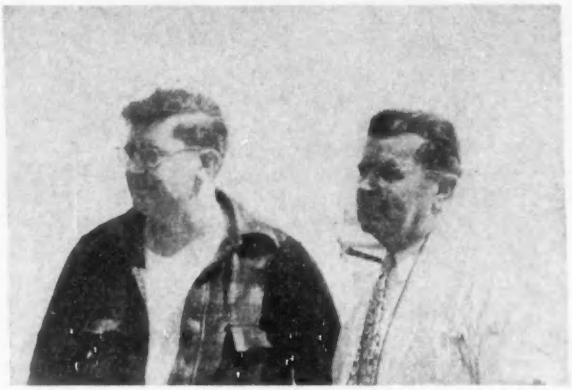
No longer associated with Air Products, Inc., Emmaus, Pa. as a design engineer, **EDWARD C. BREINIG** has taken a similar position with the Aldrich Pump Co. in Allentown, Pa.

A. F. SIERS has accepted the position of chief engineer for the General American Aerocroach Co. in East Chicago, Ind. Prior to this, he was assistant to the vice-president in charge of engineering at this company. **NORMAN E. BATESON,** who had been project engineer, is now assistant chief engineer.

ASHTON K. STONE recently became president of the Modern Petroleum Corp. in Philadelphia. This company specializes in additive type lubricating oils for the automotive field. Before this position, he was technical director of the Radbill Oil Co. in Philadelphia.

H. A. HANSEN, who for the past ten years has been in charge of sales for the Marine Carburetor & Filter Departments, Zenith Carburetor Division of Bendix Aviation Corp., has been appointed sales manager of the recently acquired Skinner Purifiers Division of Bendix. He has been an SAE member since 1923.

SAE Fathers and Sons . . . . .



CHARLES J. COOK, left, who is chassis engineer for Reo Motors, Inc., Lansing, Mich., and his father **CHARLES A. COOK.** The father is assistant chief engineer for the Wisconsin Axle Division, Timken-Detroit Axle Co., Oshkosh, Wis., and he joined SAE in 1918.

A member of the SAE since 1917 **EVAN R. NASH,** center, with his two sons, **IVAN H.,** left, and **DONALD.** The father is vice-president of the Cousins Tractor Co., Inc., in Hanford, Calif. Ivan is affiliated with the Enterprise Engine and Foundry Co. of San Francisco, and Donald is general service manager for the Caterpillar Tractor Co. of Peoria, Ill.

If any SAE reader knows of any SAE Father-and-Son or Father-and-Daughter combination, both of whom are members of the Society, your editors would appreciate hearing from you. Several SAE members have two Member-Sons.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated—we don't want to miss any SAE Father and Son or Father and Daughter grouping.

SAE Father & Daughter . . . . .

Here we present **MRS. RUTH E. DEWALD** and her father, **DANA A. SEARLE.** As far as we know, they hold the honor of being the only father and daughter in the SAE. She expects to be graduated from Wayne University, Detroit, with a B.S. in mechanical engineering in January, 1948. At present, Mrs. DeWald is assistant purchasing agent for the Machined Parts Corp. Her father, who joined SAE in 1942, is motor and chassis designer for the Packard Motor Car Co., also in Detroit.

Previously a marine engineer for the United States Maritime Commission, Washington, D. C., **HUGH HAROLDSON** has now become an instructor at California Polytechnic College, San Luis Obispo, Calif.

HERBERT L. SCHNELL is now a manufacturing consultant for the Apparatus Division of the General Electric Co. in Erie, Pa. He was formerly with the Paramount Mfg. Co., Inc., in Hillsdale, Mich.

EDWARD C. DITZEN, who had served as design engineer for the Sterling Engine Co., of Buffalo, N. Y., is now production engineer at United Engineering Co. of San Francisco. He is in charge of all engineering and production planning phases of United's expansion program.

Recently resigning as automotive engineer for the Standard Oil Co. (Ind.), **R. C. ST. JOHN** has joined the U. S. Army, now serving as a major in the Transportation Corps. At present his assignment is in the Office of the Chief of Transportation, Department of the Army, Washington, D. C.

RAYMOND O. SNODGRASS is now a retail representative for the Union Oil Co. of California, Seattle, Wash. In 1945-1946 he was Program Chairman for the Northwest Section of the SAE.

Heretofore a research engineer for McCulloch Motors Corp. in Los Angeles, **AUSTIN GUDMUNDSEN,** recently became vice-president in charge of engineering and research for the Diesel Pump & Electric Mfg. Co. of Culver City, Calif.

Prior to becoming manager of aviation sales for the Sundstrand Machine Tool Co., Hydraulic Division in Rockford, Ill., **KARL J. MOSBACHER, JR.,** was sales and application engineer in the Aviation Division of the General Electric Co., Schenectady, N. Y.

HOWARD F. KIDWELL has become manager of fleet sales for the B. F. Goodrich Co. in Akron, Ohio. He had been connected with this company in Detroit.

CLORAL O. RAINS is now employed in the Engineering Department of the Phillips Petroleum Co., Bartlesville, Okla.

Having served as an instructor in the Department of Education, Vancouver, B. C., **JAMES IRVING** is now an inspector for the Columbia Trailer Co., Ltd., Vancouver, B. C., Canada.

LLOYD J. WOLF is now a consulting engineer for the Twin Disc Clutch Co. in Racine, Wis. Prior to this, he was chief engineer of the Automotive Section of the Army Ground Forces Board No. 2 in Fort Knox, Ky.

R. WAYNE GOODALE, top, who had been assistant manager of the Products Acceptance Department at the Standard Oil Co. (Calif.), was recently promoted to manager of the Lubricants Division, replacing **GEORGE L. NEELY.** Goodale is chairman of the Northern California Section for the coming year. Neely, a past-councilor of SAE, has become vice-president of the California Oil Co. in Chicago. Oswald headed the SAE Passenger Car Body Activity in 1940, when he was an executive engineer with Olds Motor Works Division of General Motors Corp.

JOHN OSWALD, bottom, a former vice-president of the Society, and **EARLE S. MacPHERSON,** recently joined Ford Motor Co. as executive engineers reporting to Vice-President in Charge of Engineering **HAROLD T. YOUNGREN.** Both had been with General Motors Corp., the former as quality engineer and the latter has been chief of the light car division of Chevrolet Motor Division. Goodale has been appointed general chairman of the SAE National West Coast Meeting to be held next August in San Francisco. This meeting will include for the first time participation by the Fuels & Lubricants, Truck & Bus, and other SAE Engineering Activities represented on the West Coast.

Having been discharged from the Armed Forces and formerly employed by the NACA in their Aircraft Engine Research Laboratory, Cleveland, **SOLOMON M. SORIN** has accepted the position of industrial engineer with the Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.

HEADS EARLY BIRDS AGAIN

GEORGE H. SCRAGG, director of advertising & sales promotion for the White Motor Co., Cleveland, has been re-elected president of the Early Birds which is an organization for aviation pioneers. Other SAE members who were elected are WILL D. PARKER of Bartlesville, Okla., third vice-president and ROBERT MINSHALL of Cleveland, who was elected trustee for a five-year term

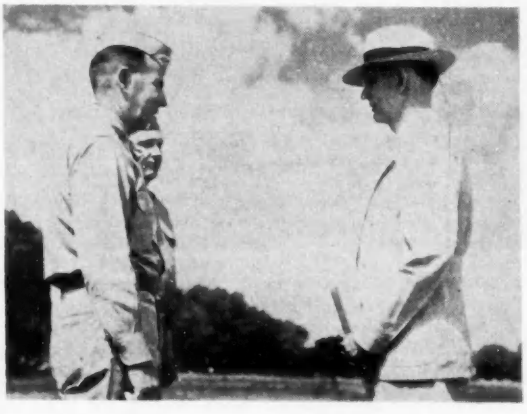
In the 28 ft. racer designed by **REID RAILTON,** British automotive engineer, JOHN COBB broke his own and world's one-mile land speed record with an average of 394.196 mph Sept. 16 at Bonneville Salt Flats, Utah. Cobb's speeds over the measured mile were 385.645 and 403.136 on the return run (See p. 61.)

ROBERT B. HAYNES has been promoted to the newly-created position of works manager for the Spicer Mfg. Division of the Dana Corp. in Toledo. His former post was equipment manager. Haynes has been with Spicer since 1935 and joined the SAE in 1920.

JOHN C. WIDMAN has been appointed chief body engineer of Kaiser-Frazer Corp., Willow Run, Mich., as announced by **DEAN HAMMOND,** chief engineer. Widman, who had been in charge of Ford Motor Company's Body Research Department for two years, previously served for 15 years with the Murray Corp. of America. He will direct developmental and engineering work on the company's current and future Kaiser and Frazer models.

HERBERT MANDELBAUM recently resigned from American Airlines, Inc., as supervisor in the Engineering Department. He has accepted a position with the consulting engineering office of Charles Mayer in New York City.

RICHARD E. HITCHCOCK recently became connected with the Curtiss-Wright Corp. in Caldwell, N. J., as a rocket research and development engineer. He was formerly employed as a project engineer for the Bendix Aviation Corp. in South Bend, Ind., and had an active part in the development of the Bendix Direct Fuel Injection system used on the B-29 warplane.



CLAUDE A. FLEETWOOD, right, civilian supervisor of the Ft. Warren, Wyo. Diesel School, is presented with an Army Commendation by LT. COL. VERN M. WILDMAN, acting commanding officer of Ft. Warren. Fleetwood received this award for meritorious civilian service performed during the war

Having served as truck and bus sales engineer for General Motors Corp. in New York, **CHARLES H. HELLING** has been made field representative in the Philippines and China for the General Motors Corp. Foreign Distributors Division. His headquarters will be in Manila.

STUART HAMILTON is now a graduate student at Cornell University in Ithaca, N. Y. Before this, he was in the Flight Research Division of the Cornell Aeronautical Laboratory in Buffalo, N. Y.

NORMAN G. SHIDLE, executive editor, SAE Journal and SAE Quarterly Transactions, was one of a six-man panel which discussed public relations as related to U. S. highway programs at the 33rd Annual Meeting of the American Association of State Highway Officials in New York City on Sept. 25.

Recently graduated from Yale University, **WILLIAM A. P. MEYER** has become an automotive engineer with the Standard Oil Co. of Ind. in Whiting.

HORACE L. ARNOLD, who had been associated with Wimberly-Arnold Co., Inc., in Jacksonville, Fla., recently became sales engineer with the Gaynon Iron Works in Jacksonville.

A board of seven consultants has been appointed by the United States Atomic Energy Commission in order to speed up the industrial opportunities in the field of atomic power. SAE members on this Commission are **DR. GUSTAV EGLOFF,** director of research for the Universal Oil Co. of Chicago and **ROBERT E. WILSON,** chairman of the board of the Standard Oil Co. (Ind.), Chicago.

B. J. LEMON retired Sept. 1 after 32 years with the United States Rubber Co. in research, development, and tire engineering. Joining the Society in 1923, he was a Councillor in 1938-39, Detroit Section chairman 1928-29, and Metropolitan Section treasurer 1938-40. During the introduction of balloon tires and front wheel braking, he was chairman of the SAE Front Wheel Alignment Committee, and has been a member of the Society's Standards, Research, Highway, Riding Comfort and other technical committees. He is the author of a number of technical papers on rubber, tires, and rims presented before both National and Section meetings. He served as a captain in transport assignments in World War I, and in World War II he was chief of the Rubber Branch and later acting chief of development, Office of the Chief of Ordnance, Detroit, as a lieutenant colonel. He was raised to the rank of colonel in the reserves upon return from military service. He will make his home in Bethel, N. Y.

Heretofore a technical engineer for the General Electric Co. in Bloomfield, N. J., **ROBERT I. BUCKALTER** has become sales engineer for the Arma Corp., Brooklyn, N. Y.

CLIFFORD A. ROURKE has recently taken over the management of the Kirkland Bearings & Parts Co., Ltd., Kirkland Lake, Ont., Canada. Prior to this post, he was a partner in the Accurate Automotive Parts & Machine Co. in Toronto.

Previously supervising engineer in the San Francisco branch office of Sweet & Crawford—Pacific Indemnity Co., **LESTER R. HILL** is now compensation underwriter with this company in Los Angeles.

CHUNG HUA WU is now a mechanical engineer for the National Advisory Committee for Aeronautics, Aircraft Engine Research Laboratory, Cleveland.

ROBERT E. THIBODEAU was recently appointed sales engineer for the Aluminum Alloys Corp. in Detroit. Prior to this, he was employed as a senior mechanical engineer for the Armour Research Foundation in Chicago.

WINSTON M. DUDLEY, who is no longer with the Case Institute of Technology in Cleveland, has joined the Engineering Research Department of the Standard Oil Co. (Ind.) in Chicago.

WALDEMAR O. BISCHOFF is now with Associated Engineers, Inc. in Springfield, Mass.

A. C. TEETSEL has joined the Universal Friction Materials Co. in Kendallville, Ind., as vice-president in charge of manufacturing. Prior to this he was with the Thermoid Co. as manufacturing superintendent of the Frictional Material Division in Trenton, N. J. He has also been connected with Ferodo & Asbestos, Inc., New Brunswick, N. J., and the Russell Mfg. Co., Middletown, Conn.

EDWARD H. HOLTZKEMPER, who had been project engineer with the Chevrolet-Cleveland Division has been transferred by General Motors Corp. to Buick where he is a project engineer on engines.

No longer a design engineer with the Chain Belt Co. in Milwaukee, Wis., **ANDREW McMILLAN** has accepted the post of mechanical products engineer with the Niagara Chemical Division of the Food Machinery Corp. in Middleport, N. Y.

WARREN R. VARCOE, formerly enrolled at Washington State University, is now a sales engineer with the Minneapolis Honeywell Regulator Co. in Portland, Oreg.

DR. GEORGE W. LEWIS, a past vice-president of SAE, has been appointed research consultant to the National Advisory Committee for Aeronautics, retiring from his post as director of NACA. He was succeeded Sept. 1 by DR. HUGH L. DRYDEN, who had been associate director of the National Bureau of Standards. **A. M. ROTHROCK,** formerly at the NACA Cleveland Laboratory has transferred to Washington as assistant director. An SAE member since 1918, Lewis' pioneering in wind tunnels has given him a world wide reputation as a leader in aeronautical research. His papers have won for him the Guggenheim Medal, the ASME Spirit of St. Louis Medal and other honors.

GROVER C. WILSON has joined the Ethyl Corp. Research Laboratories in Detroit as a coordinator on the Automotive Research staff. Previous to this, he was with the Universal Oil Products Co. in Riverside, Ill. Wilson is chairman of the SAE Diesel Engine Activity Meetings Committee and served as vice-president of the Diesel Engine Activity in 1943.

EUGENE B. EIPPER has been appointed automotive supervisor of the Petroleum Chemical Laboratory of E. I. du Pont de Nemours & Co., Inc., at the Deepwater, N. J., plant. He recently left the Wilkening Mfg. Co. in Philadelphia, where he had been assistant chief engineer for the past two years.

ROBERT B. ALEXANDER is now affiliated with the Pontiac Motor Division in Pontiac, Mich.

Previously a service manager for Kapiolani Motors, Ltd., in Honolulu, T. H., **RALPH H. MOYERS** has taken a similar position with Earl Smith Motors in Sacramento, Calif.

FRANK W. LYNCH, who had served as assistant manager of the Detroit Division of the Reynolds Co. for the last three years, was recently appointed manager of this division. Before joining Reynolds, he was with Timken Roller Bearing Co. for over nine years. Lynch graduated from Purdue University in 1935.

CHARLES MANHART received this "Paul Bunyan" size golf club from admiring fans, after making a 325 yard drive in the Bendix Engineer's Golf Tournament at South Bend, Ind. Manhart is sales manager of aircraft products at the Bendix Aviation Corp.

FRANKLIN T. "HANK" KURT, left, Grumman sales engineer, with WILLIAM HANNIGAN, mechanic of the company, carrying kerosene ashore to Ship Island, off Gulfport, Miss., Sept. 21 after the recent hurricane had hit the vicinity. Flying a Grumman Mallard, sold to the New York Daily News, Kurt, a former member of the Metropolitan Section Governing Board, helped to locate the six stranded persons on Ship Island. The airplane in the background, Miss Daily News, assisted the Coast Guard in rescue work during the blow

Third edition of "Torque Converters or Transmissions," by **P. M. HELDT**, has recently been published. First published in 1942, the book has been brought up-to-date, particularly with regard to latest types of automatic transmissions for passenger cars and buses.

WILLIAM J. MILLER, who is widely known in Pacific Northwest trucking circles, has become associated with the Seattle branch of the Great-West Life Assurance Co. He was formerly with the War Production Board and with the War Assets Administration. His last post was president and general manager of the Washington Truckstell Sales Inc. in Seattle.

Now a sales engineer in the Viskon Division of the Visking Corp., Chicago, **A. S. KIEFER** had been an automotive engineer with the Sinclair Refining Co., same city.

BRIAN G. ROBBINS is now assistant secretary of the Institution of Mechanical Engineers in London, England.

FRANK W. OLSON, JR., who recently graduated from Oklahoma A. & M. College, Stillwater, Okla., is engaged in drafting and engineering work on municipal Propane-Butane gas systems for the Phillips Petroleum Co. in Bartlesville, Okla.

CHARLES H. LOFTHOUSE, who is a sales engineer and consultant with L. Feldman & Co. in Chicago, has been lecturing on atomic theory, war missiles and projectiles, and other engineering subjects. This fall he spoke before an engineering group in Winnipeg, Canada, on Atomic Energy – How it operates within the atom bomb, what takes place within the bomb itself.

No longer a project engineer of the Fuel Cell Division, United States Rubber Co. in Los Angeles, **JOHN EDWIN SAKALY, JR.,** has become an instructor in the Engineering School of Loyola University of Los Angeles. In 1945 he was a member of the Membership Committee of the Southern California Section.

HARLEY W. DRAKE has become president of the Drake Equipment Co. in Petaluma, Calif. He had been sales manager of the Bay Cities Equipment Co. in Oakland, Calif. Drake has been a very active member of the SAE and is a past chairman of both the Northwest and Oregon Sections.

WILLIAM W. SHARON is now an engineer with the Standard Oil Development Co. in Linden, N. J.

JOHN H. DANNAN is now a design engineer with Consolidated Vultee Aircraft Corp. in San Diego, Calif. Prior to this post he was an assistant project engineer with the Airesearch Mfg. Co. of Los Angeles.

Having served as powerplant engineer with Trans World Airline, Inc., in Newcastle, Del., **PERRY A. CLARK** recently became industrial salesman with the Texas Co. in Los Angeles.

When **ROBERT M. CRITCHFIELD,** left, was promoted from chief engineer to factory manager of Delco-Remy Division of General Motors Corp., Anderson, Ind. (p. 80, Sept., 1947, SAE Journal), **J. H. BOLLES** was named chief engineer of the company. Long active in SAE technical committee work, Critchfield is chairman of the Electrical Equipment Committee and is a former chairman of the Indiana Section.

M. GOLDSMITH, who is now managing director of Metalastik, Ltd., Leicester, England, has arrived in the U. S. for a two-month business trip and expects to visit the leading firms in the automotive and rubber industry. Correspondence can reach him at 69-11 Yellowstone Blvd., Forest Hills, L. I., N. Y.

T. C. HOWE, previously equipment superintendent of the North Coast Transportation Co. in Seattle has been appointed manager. He has been associated with the bus business in Oregon for 24 years and joined North Coast in 1928 as a mechanic. Howe was chairman of the Northwest Section of the SAE in 1941.

OBITUARIES

ROBERT W. MINER

Following a brief illness caused by bulbar poliomyelitis, Robert W. Miner, 29, a mechanical engineer with Aeroquip Corp., Jackson, Mich., died Sept. 2 in a hospital there. His father is Robert I. Miner, chief engineer of Ryerson & Haynes, Inc., of that city.

A graduate of Case Institute of Technology in 1940 and of Chrysler Institute of Engineering, he served in the U. S. Coast Guard Auxiliary during the war.

Active in his community, he was a leader in Boy Scout work, an officer of his church, and secretary of the Jackson Engineers Club.

HEATLEY GREEN

Heatley Green, who had been a pioneer automotive parts manufacturer, passed away in Detroit on Sept. 20.

At the time of his death, Green was president of the Automatic Products Co. and the Bangor Investment Co., Detroit. He went to Detroit in 1901 following his graduation from Cornell University, and established the Automatic Products Co. in 1913. He had been a member of the SAE since 1912.

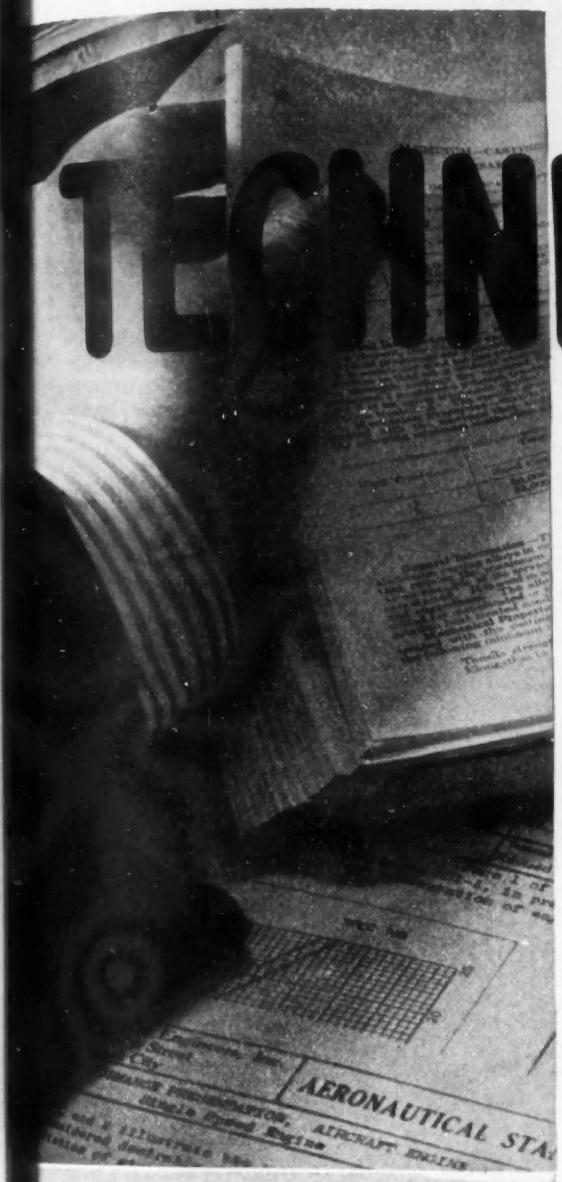
DUIS W. MEADOR

A former editor of the Metropolitan Section's "Accelerator," Duis W. Meador died in New York City on Sept. 14 after a lingering illness.

He graduated from New York University in 1939, and then joined the Engineering Department of Wright Aeronautical Corp. in Wood-Ridge, N. J. At the time of his death, he was assistant project engineer with this company.

Meador joined SAE in 1940, served on the governing board of Metropolitan Section for several years, was editor of the "Accelerator" from 1942 to 1945, and chairman of the section's Reception Committee in 1946-1947.

TECHNICAL COMMITTEE PROGRESS



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First Jet Alloy Specs Evolved by SAE Group

Nineteen new SAE Aeronautical Material Specifications for heat and corrosion-resistant alloys used in aircraft jet engines – first standard specifications of their kind in the world – were recently approved by the SAE Technical Board.

These new materials successfully withstand 2000F operating temperatures and have extended between-overhaul periods beyond the 140-hr mark.

Development of these alloys aided considerably in the return to this country of the absolute world aircraft speed record for the first time since 1923. Within the past few months American jet planes shattered the international speed record three times – first, the Lockheed P-80 Shooting Star and twice, the Douglas D-558 Skystreak.

Prepared by the SAE AMS Corrosion and Heat Resistant Alloys Committee headed by A. W. F. Green, Allison Division, GMC, these 19 specifications give the industry a tool for buying these new jet engine materials to standard chemical composition and to accepted performance and quality requirements.

Thorough coordination with suppliers and all Committee members preceded processing of the specifications through the SAE Aeronautics Committee and Technical Board.

To facilitate usage, each specification indicates where the material may best be applied. The set of 19 specifications includes alloys for critical gas turbine parts such as turbine blades or buckets, tail pipes, exhaust cone assemblies, burner liners,

and fluid lines, and other critical parts.

Particularly noteworthy specifications in this series are the six covering alloys for precision investment casting (lost wax process) such as vitallium and stellite. Since each jet engine requires several hundred buckets or blades, fast yet precise fabrication is a must. Finding these alloys with heat and corrosion-resistant properties that can be precision-cast was a major factor in licking the turbine blading problem.

Now available from the SAE, the new jet alloy AMS series includes the following specifications:

1. AMS 5360 – Steel Castings, Precision Investment, Corrosion and Heat Resistant, 17Cr – 13Ni – 2Mo

Application: Small parts such as stator vanes and nozzle diaphragm vanes for use at temperatures up to 1600F. At high temperatures, strength of this steel is slightly higher than, and oxidation resistance is similar to, that of 18-8 types.

2. AMS 5365 – Steel Castings, Sand, Corrosion and Heat Resistant, 25Cr – 20Ni

Application: Parts such as nozzle diaphragm vanes and assemblies and parts requiring welding during fabrication.

3. AMS 5366 – Steel Castings, Precision Investment, Corrosion and Heat Resistant, 25Cr – 20Ni

Application: Same as AMS 5365.

4. AMS 5375 – Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base –25Cr – 5W

Application: Primarily small parts such as turbine blades and buckets requiring high strength up to 1500F and oxidation resistance up to 2000F.

5. AMS 5378 – Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base 25Cr – 32Ni – 5Mo

Application: Same as AMS 5375.

6. AMS 5380 – Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base – 25Cr – 15Ni – 6Mo

Application: Same as AMS 5375.

7. AMS 5385 – Alloy Castings, Precision Investment, Corrosion and Heat Resistant, Cobalt Base – 27Cr – 2Ni – 5Mo

Application: Same as 5375.

8. AMS 5512 – Steel Sheet and Strip, Corrosion and Heat Resistant, 18Cr – 11Ni – Cb

Application: Especially for parts and assemblies requiring welding during fabrication.

9. AMS 5517B – Steel Sheet and Strip, Corrosion Resistant, 18Cr – 8Ni (Cold Rolled – 125,000 psi)

Application: For drawing or forming.

10. AMS 5518B – Steel Sheet and Strip, Corrosion Resistant, 18Cr – 8Ni (Cold Rolled – 150,000 psi)

Application: For moderate forming and bending.

A. W. F. Green, Chairman

SAE AMS Corrosion and Heat Resistant Alloys Committee

11. AMS 5519C – Steel Sheet and Strip, Corrosion Resistant 18Cr – 8Ni (Cold Rolled – 185,000 psi)

Application: For moderate bending.

12. AMS 5522 – Steel Sheet and Strip, Corrosion and Heat Resistant, 25Cr – 20Ni –2Si

Application: Parts requiring welding during fabrication. Strength at elevated temperatures similar to that of 18-8 types. Specified silicon content improves oxidation resistance with some sacrifice of welding and ductility.

13. AMS 5530 – Alloy Sheet, Corrosion and Heat Resistant, Nickel Base – 17Mo – 15Cr – 6Fe – 5W

Application: For parts such as welded nozzle diaphragm assemblies, burner liner parts, tail pipes, exhaust cone assemblies, and others requiring high strength up to about 1700F and oxidation resistance up to 2000F.

14. AMS 5532 – Alloy Sheet, Corrosion and Heat Resistant, Iron Base 20Cr – 20Ni – 2Co – 3Mo – 2W – 1Cb

Application: Same as AMS 5530.

15. AMS 5542 – Alloy Sheet, Corrosion and Heat Resistant, Nickel Base – 15Cr – 2.5Ti – 1Cb – 0.7A1

Application: Primarily parts such as buckets, blades, nozzle diaphragm vanes, burner liners and domes, requiring high strength up to 1500F and oxidation resistance up to 1800F. Also for parts to be formed and heat-treated to improve strength at elevated temperatures. Processing and heat treatments affect available properties at elevated temperatures.

16. AMS 5560B – Steel Tubing, Seamless, Corrosion Resistant, 18Cr – 9Ni

Application: Parts and assemblies such as fluid lines not subject to high pressure and where welding is not used for fabrication.

17. AMS 5642 – Steel, Corrosion and Heat Resistant, 18Cr – 11Ni – Cb (Free Machining)

Application: Primarily for parts subjected to high temperatures during fabrication or in service, but not for parts to be fusion welded.

18. AMS 5646 – Steel, Corrosion and Heat Resistant, 18Cr – 11Ni –Cb

Application: Especially for parts requiring welding during fabrication.

19. AMS 5652 – Steel, Corrosion and Heat Resistant, 25Cr – 20Ni – 2Si

Application: Parts such as nozzle diaphragm vanes and assemblies which require welding during fabrication.

Chairman Green reports that the Committee has completed only the first phase of the project assigned to it by the SAE Aeronautical Material Specifications Subdivision, chairmanned by J. B. Johnson, Air Materiel Command. It will continue to keep abreast of this new metallurgical field by revising or adding to these specifications in accordance with industry demands.

'Copter Specialists Search Design Facts

FOUR new SAE Helicopter Committee projects converge on finding ways to predict and extend the life of helicopter components.

The four projects are:

1. Bench and Flight Procedure for Determining Service Life of Rotor Blade Structure;

2. Determination of Load Factors for Helicopters;

3. Friction Oxidation;

4. Transmission Temperatures.

To Aid Rotor Design

Reason for developing information on determining the service life of rotor blade structures is to set up an accelerated test procedure demonstrating structural suitability of these units in actual flight. Complex features in rotor blade design require tests simulating operational loadings.

J. P. Perry, Firestone Aircraft Co., prepared a preliminary draft of suggested procedures. It says that selecting the proper fatigue test condition is one of the most difficult tasks confronting the designer in such a program. Loadings equal to one and one-half times the values associated with normal rated rotor speed at level flight speed of the aircraft are suggested.

Determination of helicopter loadings is particularly important to the designer striving to predict by calculation performance and life of a helicopter in flight. Preliminary steps in

that direction are being taken by a subcommittee, under Dr. Alexander Klemin, that is defining and outlining essential load conditions.

This group is now drafting a tentative report covering load conditions on the ground, during take-off, in flight, in maneuvers, and with wind gusts acting on the craft. Dr. Klemin reported that this preliminary work is but the first phase of the subcommittee's objective of compiling a report on determination of load factors both by flight tests and by analytical methods.

L. L. Douglas, Kellett Aircraft Corp., was assigned the task of uncovering information on friction oxidation. He defines this phenomenon as a deterioration of surfaces in contact under pressure (usually high) and relative movement (usually small) that roughens the surface and creates red iron oxide.

As a starting point, Douglas has sent a questionnaire to the industry to accumulate all known experience with, and literature on, friction oxidation.

Transmissions a Problem

Fourth new project, study of helicopter transmissions and their lubrication problems, stems from the discrepancy in the helicopter industry on lubrication and cooling of transmissions. The helicopter transmission has a highly-loaded gear reduction of about 10 to 1. Engine shaft input speeds range from 2000 to 3000 rpm and gear tooth loadings are similar to those in aircraft engines.

A questionnaire prepared by R. A. Wolf, Bell Aircraft Corp., has been sent out to all manufacturers of helicopters, aircraft engines, and transmission gears as well as oil suppliers to collect and coordinate data and experience on the subject.

Chairman R. H. Prewitt, Prewitt Aircraft Corp., advises that the Committee made further study of the material covered in its Aeronautical Information Report No. 15, Desired Characteristics for Helicopter Wheels, Tires, and Brakes. Based on these recent investigations of new helicopter models, the committee finds it advisable to bring the report up-to-date by modifying several factors related to helicopter wheel design.

Industry Interest

Another item of interest reported by Chairman Prewitt at the last meeting is that eight helicopter development and manufacturing companies, other than those with members on the Committee, have requested all information issued by the Committee. They are Landgraf Helicopter Co., Marquardt Aircraft Co., Doman-Frasier Helicopters, Inc., American Helicopter Co., Jet Helicopter Corp., Helicopter Engineering and Construction Corp., Penn Elastic Co., and Sun Helicopter Co.

Members recently added to the Committee are Major W. C. Dodds, Air Materiel Command; Joseph Stuart, United Helicopter Co., and J. A. Johnson, Bendix Helicopter, Inc.

Study Dimensioning For Aero Drafting

SAE Committee S-1 project currently stimulating much controversy is progressive dimensioning versus base line dimensioning.

The conferees are in disagreement over which of the two methods, shown in Fig. 1, is progressive dimensioning and which should be called base line dimensioning. From a manufacturing standpoint it would appear that a system of dimensioning from a single reference surface has an advantage. This prevents cumulative addition of tolerances.

Another Committee project slated for the SAE Aeronautical Drafting Manual comprises a list of common drafting pitfalls that impede blue print interpretation. P. G. Clark, Curtiss-Wright Corp., Propeller Division, prepared a recommendation showing the wrong and the right way "of doing it." Many of these items involve dimensioning and general notations.

For example, leaders should be repeated as often as necessary and not duplicated to avoid long leaders or line crossing. Extension and dimension lines should not cross each other unnecessarily. Also recommended is elimination of erasing practices which mar or destroy the surface of original drawings. Use of a knife, glass, or sand eraser and sharp-pointed drawing instrument accelerates drawing deterioration.

These and other separate items in Clark's report will be added to appropriate sections of the Manual.

Chairman O. E. Kirchner, American Airlines, Inc., tells of work under way on rivet and bolt patterns being handled by Ross Goodlet, Trans World Airline. This concerns the symbolizing and coding of rivet and bolt holes. Current industry practice in this area lacks uniformity. Chairman Kirchner considers standardization of such notations extremely valuable to airline operators, aircraft manufacturers, and other Manual users working with sheet metal.

Helical Gear Notations

He also reports progress on the dimensioning of helical gears, a project assigned to Prof. S. B. Elrod, Purdue University. Prof. Elrod has prepared a proposal to be circulated among gear manufacturers and revised in accordance with recommendations received.

At the last meeting Chairman Kirchner, on behalf of the Committee, thanked John Perrin, who is retiring from Pratt & Whitney and the Committee, for his many contributions to the Manual. Perrin headed Committee E-8 which developed the original SAE drafting manual, Manual of Aircraft Engine Drafting Room Practice. He will continue on the Committee as a consultant. Joseph Stannard, of Pratt & Whitney Aircraft, has been added to the membership.

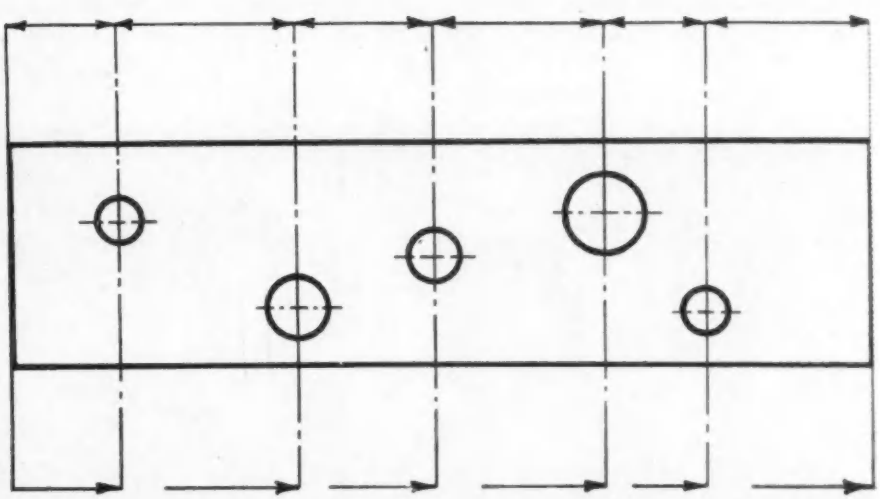


Fig. 1 – SAE Committee S-1 is weighing the relative merits of the two dimensioning systems shown. One is progressive dimensioning and the other base line dimensioning; but which is which the committee has yet to decide

SAE President C. E. Frudden (left) and Governor Dwight M. Green of Illinois, spoke briefly before Paul Hoffman (right) delivered the first Beecroft Memorial Lecture

HOFFMAN

Gives Beecroft Lecture

AMERICA'S highway death toll must be cut in half during the next 20 years in the face of a 50% increase in motor travel, Paul G. Hoffman, president of Studebaker Corp. declared in delivering the first Beecroft Memorial Lecture before the SAE Chicago Section at the Hotel Knickerbocker on Oct. 14.

Flanked by a speakers table of distinguished guests including the Governor of Illinois, Dwight M. Green, Chicago Section Chairman W. W. Davies opened the meeting and introduced Chicago Section Passenger Car Vice-Chairman T. A. Scherger, who was in charge of arrangements for the memorable event. Toastmaster Pyke Johnson, president, Automotive Safety Foundation and chairman of the Beecroft Board of Award, took over after being introduced by Scherger.

Johnson stressed his committee's hope that the 10 Beecroft Memorial Lectures will contribute to a wider understanding of the need for safer and more efficient highway transportation and said, "If that is accomplished the lectures will have justified the faith and fulfilled the hope of the man whose legacy gave them to us."

Governor Green paid tribute to the speaker of the evening and outlined a constructive program for fulfillment of Illinois highway and traffic needs.

SAE President C. E. Frudden voiced the Society's indebtedness to Past-President David Beecroft for having made it possible for SAE to express anew its consistent and deep desire to contribute its share to the great task of improving traffic safety.

Accident Rate Must Come Down

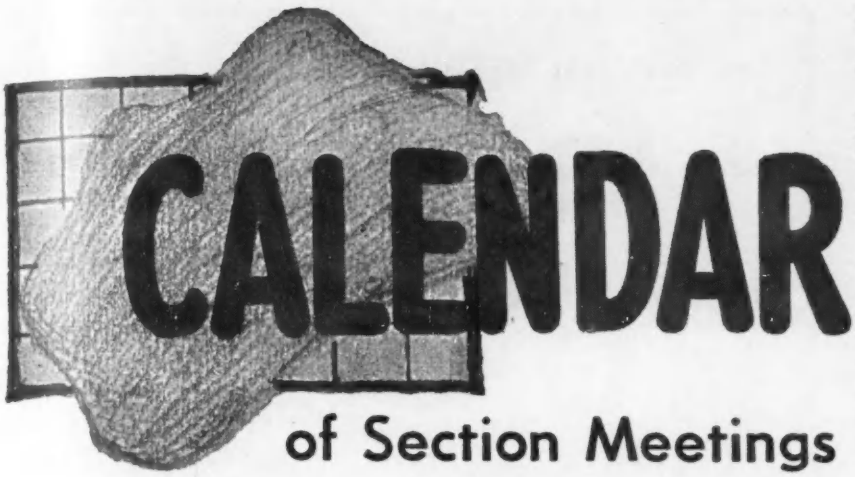
The Hoffman lecture was replete with significant fact and stirring call to action. If the current national rate of eight deaths per 100 million vehicle miles should continue, he said, the toll would climb to 50,000 fatalities and nearly 2,000,000 injuries by 1967.

"Such a prospect is unthinkable," he continued. "The toll cannot be permitted to go up as travel increases. On the contrary, it must be cut at least in half during the next two decades—which means forcing down the fatality rate from eight to three."

He described this as a "clearly attainable goal," but warned that "it will take the active support of every individual and every organization of public-spirited citizens in the country."

(This first Beecroft Memorial Lecture delivered by Paul Hoffman will be printed in full in the December SAE Journal.)

Paul G. Hoffman receives the first Beecroft Memorial Award for outstanding contributions to traffic safety. (Left to right) T. A. Scherger, Chicago Section Passenger Car vice-chairman; Paul Hoffman; W. W. Davies, Chicago Section Chairman; and Pyke Johnson, chairman of Beecroft Board of Award



# of Section Meetings

Baltimore – Nov. 13 and Dec. 11

Nov. 13 – Engineers Club, dinner 7:00 p.m. Synthetic Lubricants – Speaker to be announced.

Dec. 11 – Old Timers' Night.

British Columbia – Nov. 10

Georgia Hotel, Vancouver; dinner 6:30 p.m. New Developments in Radiation – Fred M. Young, president, Young Radiator Co.

Central Illinois – Nov. 24

Nov. 24 – Jefferson Hotel, dinner 6:30 p.m. Use of Heavy Equipment in Construction of Airports – General Sturgens, U. S. Army Air Force.

Chicago – Nov. 11

Hotel Knickerbocker; dinner 6:45 p.m., meeting 8:00 p.m. Selecting and Planning the Truck for the Work It Must Do – Fred B. Lautzenhiser, consulting engineer, Motor Truck Division, International Harvester Co.

Cincinnati – Nov. 13

Engineering Whys of the Modern Tractor – SAE President C. E. Frudden, consulting engineer, Allis-Chalmers Mfg. Co.

Cleveland – Nov. 10

Cleveland Club – dinner 6:30 p.m. Speaker – Walter T. Olson, chief of the Combustion Branch, NACA Flight Propulsion Research Laboratory. Olson will discuss his recent tour of the aircraft gas turbine industry in England. Speaker-Sponsor: E. Manganiello, National Aeronautical Corp. of America.

Dayton – Nov. 12

Miami Hotel; dinner 6:30 p.m. Engineering Whys of the Modern Tractor – SAE President C. E. Frudden, consulting engineer, Allis-Chalmers Mfg. Co. Motion Picture – Tractors at Work.

Detroit – Nov. 3 and 17

Nov. 3 – Horace H. Rackham Educational Memorial Building; 8:00 p.m. Methods of Measuring Torsional Vibration – L. F. Hope, assistant head, mechanical engineering department, General Motors Research Laboratory.

Nov. 17 – Horace H. Rackham Educational Memorial Building; dinner 6:30 p.m. Body Styling Today – Raymond Loewy, Raymond Loewy Associates. Dinner speaker – A. W. Ward, publisher, Ward's Automotive Reports. Subject – The Economic Outlook.

Pittsburgh – Nov. 25

Webster Hall; dinner 6:30 p.m. Meeting at Mellon Institute, 8:15 p.m. Gasoline from Coal – Dr. Howard S. Turner, assistant director of research, Pittsburgh Consolidation Coal Co.

Indiana – Nov. 11

Hotel Antlers; dinner 7:00 p.m. Engineering Whys of the Modern Tractor – SAE President C. E. Frudden, consulting engineer, Allis-Chalmers Mfg. Co.

Metropolitan – Nov. 19

Hotel Pennsylvania; meeting 7:45 p.m. The Know-How of the Selection of the Light-Duty Truck for your Operation – seven-man symposium: W. E. Conway, William Black, T. A. Drescher, Harvey Earl, F. K. Glynn, John W. Limpert, and R. W. Thomas.

Northwest – Nov. 7

Gowman Hotel; dinner 7:00 p.m. New Developments in Radiation – Fred M. Young, president, Young Radiator Co.

St. Louis – Nov. 18, Dec. 4

Nov. 18 – Inspection Trip, Carter Carburetor Corp.

Dec. 4 – Engineering Whys of the Modern Tractor – SAE President C. E. Frudden, consulting engineer, Allis-Chalmers Mfg. Co. Cocktail hour sponsored by Sterling Aluminum Products Co.

San Diego – Nov. 19

San Diego Electric Railway "L" St. Bus Shops – 7:30 p.m. A tour of shops to observe maintenance. Motion picture courtesy of ACF-Brill Bus Mfg.

So. California – Nov. 18

Rodger Young Auditorium; dinner at 6:30 p.m. New Developments in Radiation – Fred M. Young, president, Young Radiator Co.

So. New England – Nov. 5

Hotel Taft, New Haven; dinner 6:30 p.m. Meeting at Strathcona Hall, New Haven. Radar As An Aid to Aircraft and Marine Navigation – L. H. Lynn, sections engineer, Aviation & Marine Engine Section, General Electric Co.

Spokane-Intermountain – Nov. 5

Desert Hotel; dinner 7:00 p.m. New Developments in Radiation – Fred M. Young, president, Young Radiator Co.

Twin City – Nov. 6

Curtis Hotel, Minneapolis; dinner 6:30 p.m. Discarded Designs Don't Die – Howard S. Currier, chief engineer, Ford Passenger Car Division, Ford Motor Co.

Virginia Group – Nov. 17

Cocktail hour 6:30 p.m., dinner 7:00 p.m., meeting 8:00 p.m. New Tires – J. E. Hale, Firestone Tire & Rubber Co.

Washington – Nov. 11

Broadmoor Hotel; dinner 7:00 p.m. W. C. Bauer, technical chairman. Motion picture.

Williamsport Group – Nov. 3

Anglers Club; dinner 6:45 p.m. Marine Engines – Lew Crafts, Norfolk, Va.

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
ANNUAL and ENGINEERING DISPLAY	Jan. 12-16	Book-Cadillac, Detroit
PASSENGER CAR and PRODUCTION	Mar. 3-5	Book-Cadillac, Detroit
TRANSPORTATION	Mar. 30-31, Apr. 1	Bellevue-Stratford, Philadelphia
AERONAUTIC and AIR TRANSPORT	Apr. 13-15	New Yorker, New York City
SUMMER (Semi-Annual)	June 6-11	French Lick Springs, French Lick, Ind.
WEST COAST	Aug. 18-20	St. Francis, San Francisco

J. L. McCloud Materials Nominee for 1948 V.P.

J. L. McCloud, head, department of chemical engineering, Ford Motor Co., has been nominated for 1948 Vice-President representing the newly-authorized Engineering Materials Activity.

His name appears on the official ballot which has been mailed to members, along with those of the other nominees for 1948 offices previously published in the September SAE Journal.

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1948 Annual Meeting Plans Make Headway

STREAMLINED for the greatest convenience of members attending, the SAE 1948 Annual Meeting will consist of 24 Technical Sessions with at least 47 papers, according to a preliminary report by Chairman George Delaney of the SAE Meetings Committee.

The meeting, which begins on Jan. 12 at the Book-Cadillac Hotel in Detroit, continues throughout the week. The number of sessions sponsored by each of the 12 SAE Engineering Activities has been limited, and there will be triple simultaneous sessions only once during the week.

Numerous previews of engineering developments have been promised by many of the Activity Meetings Committees in their choice of paper topics and authors scheduled for their contributions to the next Annual Meeting of the Society. These range from materials to basic design considerations of passenger cars, trucks, buses, tractors, and aircraft and their components.

How designers of jet engines are looking to ceramics for blades and blade coatings will lift the curtain to disclose developments in this advanced field of aircraft powerplants, and a strong international flavor will be injected into world air transportation by overseas speakers.

Aircraft papers will range from cabin supercharging to stability measurements and vibration problems in helicopter engineering.

Literally "progress reports" on diesel engineering will be found in the diesel engineering sessions, which will consist of follow-ups of previous SAE papers offered by that Activity's Meetings Committee.

SAE NATIONAL MEETING

AIR TRANSPORT ENGINEERING

DEC. 1-2-3

HOTEL CONTINENTAL
KANSAS CITY, MO.

MONDAY, DECEMBER 1

10:00 A.M.

C. P. Graddick, Chairman

The Determination of the Optimum Airplane-Powerplant Combination – J. H. Brewster III, Fairchild Engine and Airplane Corp.

Cargo Aircraft Requirements – R. D. Speas and J. J. Casey, American Airlines.

2:00 P.M.

SAE-ASCE JOINT SESSION

Charles Froesch, Chairman

The Design of Airport Terminal Buildings – Walther Prokosch, George S. Armstrong Co.

Economical Airport Planning – H. O. Wright, Jr., Public Airport Services, Inc.

8:00 P.M.

J. G. Borger, Chairman

Problems of International Standardization of Civil Air Regulations – E. P. Warner, International Civil Aviation Organization.

TUESDAY, DECEMBER 2

10:00 A.M.

John Collings, Chairman

Air Transport Ground Operating Costs – Robert Ferguson, Pan American Airways.

Standardization and Simplification for the Air Transport Industry – William Littlewood, American Airlines.

2:00 P.M.

SAE-ASCE JOINT SESSION

H. H. Howell, Chairman

Importance of Noise Reduction in Airport Location and Layout – J. M. Picton, Kansas City Plan Commission.

Problems of Noise Reduction from the Airplane Design Standpoint – H. L. Ericson, Douglas Aircraft Co., Inc., and Chairman, AIA-ARTC Noise Reduction Subcommittee.

8:00 P.M.

T. P. Wright, Chairman

Proposed Air Traffic Control and Controlled Handling Systems for High Speed Aircraft – Brig. Gen. Milton W. Arnold, Air Transport Association of America.

WEDNESDAY, DECEMBER 3

10:00 A.M.

Leslie Myers, Chairman

Aircraft Engine Trouble Shooting and Maintenance – Col. Mark J. Maidel, Scandinavian Airlines System.

2:00 P.M.

Tour of TWA Overland Base

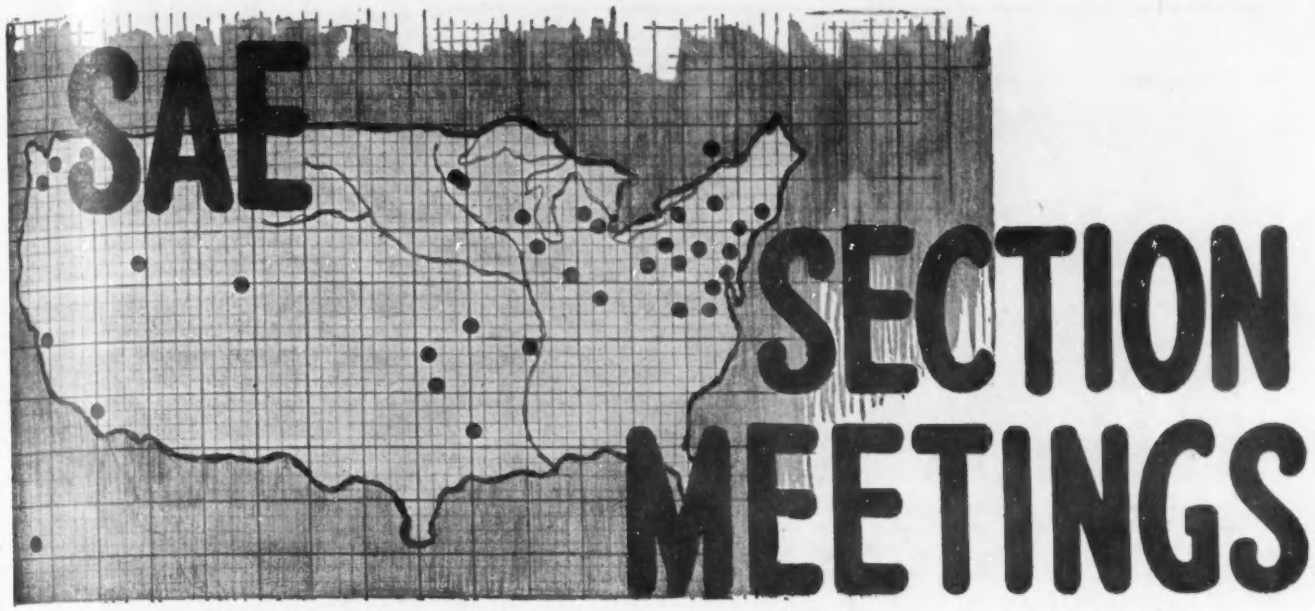
■

6:30 P.M. Continental Room

DINNER

Welcome — W. E. Briece, Chairman
SAE Kansas City Section
La Motte T. Cohu, Toastmaster
C. E. Frudden, SAE President

A Special Inquiry on Air Safety
JAMES M. LANDIS, Chairman
Civil Aeronautics Board



Ricker Reviews 500-Mile Classic

by CEORGE E. DAKE, JR., Field Editor

WESTERN MICHIGAN Section, Sept. 25 – The Indianapolis Speedway once again held the spotlight – this time in Muskegon – when Chester S. Ricker, the AAA director of timing and scoring at the Speedway since 1913, told of the various developments that have taken place in racing cars and track techniques.

In 1913, Ricker said, it took 5 to 6 min for a normal pit stop. No one worried much about oil consumption, and a car used as much as 55 gal for one race. Ply separation made tires a real problem; three or four changes were required during a race. Cars usually carried a mechanic as well as a driver. Speeds averaged 75 mph.

Today, on the other hand, a pit stop to change four tires and refuel takes only 70 sec. Oil consumption is low, as a car is allowed only 6½ gal for a race. Safety of the present Firestone-made tires is proved by the fact that many cars complete the entire 500 miles on one set. Today a car carries only the driver at speeds up to 170 mph.

This year, Ricker said, the first two cars to finish were new throughout . . . designed by Lou Moore and taken straight from drawing board to race. All types of engine are used in design – some have superchargers, some use blowers, and others have neither. Alcohol or high octane gasoline is used for fuel. Castor oil is the predominate lubricating medium, since gasoline has no tendency to break it down. Some cars are without differentials, but their maneuverability is reduced. Most brakes now used are the conventional type, although one model had the brake drums mounted in the chassis on either side of the differential. Usually two drag links are used on the steering mechanism instead of one and a tie rod.

Ricker stressed the importance of the 500-mile classic as a proving-ground for future automobile and airplane designs.

Texas Members Tour Remanufacture Plant

by W. E. LIND, Field Editor

TEXAS Section, Sept. 24 – At the invitation of William S. Binning, president of International Engine Rebuild Corp., members were taken on an inspection tour of this company's unique new plant at Garland, Texas. After the tour, B. H. Crandall, vice-president in charge of engineering and production, described production methods in the remanufacture of engines. Section Chairman Floyd Patras presided and introduced the speaker.

Binning arranged to keep the factory in full operation until 8:00 p.m. so the visitors could see all processes in operation. Crandall took one group of visitors around the plant; E. M. Blumenfeld, sales manager, took another, and John H. Hassinger, director of procurement, the third. They explained all the operations involved in rebuilding parts, line assembly, dynamometer tests, and other processes.

Crandall said a billion dollars' worth of wartime engineering development was responsible for the birth of this new and vital industry of engine remanufacturing. In fact, it played no small part in the winning of the war.

After months of preparation, the new factory has recently gone into largescale production. Capacity is about 2000 engines of all types per month, but present production is held to about half that because of limited availability of certain necessary new parts.

To assure high product quality and long engine life, an inspection system has been installed that embraces, among other items, a system of final tests parallel to the engine test methods of the foremost design and manufacturing laboratories.

Shown at Texas Section's Sept. 24 plant-tour meeting are (l. to r.) John T. Wade, Section secretary; Claude Peebles, vice-chairman; Floyd Patras, chairman; B. H. Crandall, vice-president in charge of engineering and production, International Engine Rebuild Corp.; and E. M. Blumenfeld, the company's sales manager

Veterans at Hartford Show

Shown around a 1913 Pope-Hartford exhibited at Hartford's Golden Automobile Jubilee are Lee Rockwell, John Perrin, George Dunham, Southern New England Section Chairman Richard C. Molloy, Percy Weldon, Charles Whittlesey, Dwight Judson, Dave Waite and Fred Law.

Hartford Pioneers Celebrate Automobile's Golden Jubilee

by A. M. WATSON, Field Editor

SOUTHERN NEW ENGLAND Section, Sept. 17 – Pope-Hartfords, Columbias, Stanleys, Pierces, and other almost-forgotten automobiles held the spotlight today as Hartford proved its claim to fame in automotive history.

Southern New England Section celebrated the city's Golden Automobile Jubilee with a banquet honoring 50 Hartford pioneers of the industry. Eight pioneers acted as consultants at the exhibition of old cars. On hand to point out features of the antique automobiles they helped to develop were George W. Dunham, Dwight R. Judson, Lee Rockwell, John Perrin, Ralph Barron, Charles B. Whittlesey, Percy Weldon, and Fred W. Law, who designed and built in 1897 the first gasoline cars produced in the United States on strictly European lines.

Celebration publicity emphasized the vital role played by the SAE as the "communication system" of the industry, fostering research, spreading knowledge and achieving universally acceptable standards to enable true mass production.

The jubilee celebration was touched off Tuesday evening, Sept. 16, with a parade of old cars through downtown Hartford. Accompanied by two martial bands, a contingent of the Connecticut National Guard, and the Putnam Phalanx, and illuminated with flares and Army searchlights, the procession sputtered its way to the State Armory where a group of 125 old cars was on exhibit the next day.

Over 3000 people visited the show and marveled at the sparkling condition of the old cars. Special recognition was given the vast amount of work, time and money that went into restoration of the "relics." Each car was presented with a special commemorative license plate by the State. Dozens of makes, with names long forgotten by many, relived their glory for a few hours.

The "good old days" were the main topic of conversation at the banquet, in the Hotel Bond, where 374 honored founders of the industry.

Main speaker was Col. H. W. Alden, another Hartford pioneer and a past president of the SAE. Alden reminisced about the days when he worked with Hiram Maxim, Hayden Eames, Albert Pope, George Day, Henry Souther, Herman Cuntz and Fred Law. The Colonel took particular delight in pointing out design innovations – such as water injection, four-wheel drive and variable speed clutches – that were tried in the days of Hartford's automotive prominence and today are returning to the spotlight.

Alden spoke to an audience many of whom could remember the days when requisite emergency equipment included a coil of soft iron wire and a can of Dixon's Graphite Grease No. 5. He told of the many occasions when one of these or a whittled-down piece of hickory got him back to Hartford safely.

Most of the old cars in the exhibit participated next day in the Glidden Tour, a reenactment of a 42-year-old event that covered 500 miles of New England.

Also participating in the Jubilee celebration were the Hartford Chamber of Commerce, the Veteran Motor Car Club of America, Antique Auto Club, Horseless Carriage Club, and the Hartford Automobile Dealers Association. Local newspapers, radio stations, manufacturers, and the State of Connecticut also contributed substantially to the success of the event.

Buffalo Industry Speaks At SAE Section Meeting

by ROBERT BEST, Field Editor

BUFFALO Section, Sept. 26 – Buffalo's Trap and Field Club was the scene of movies, exhibits, and a five-speaker program today as Buffalo Section members devoted their first meeting of the season to highlighting contributions of the Buffalo area to the automotive and transportation industries. Exhibits included working models of Liftomatic and Ventomatic window opening devices supplied by Trico Products Co.; cut-away models of vane and piston type shock absorbers for automotive equipment, shimmy dampers for aircraft, and viscous crankshaft dampers shown by Houde Engineering Division of Houdaille-Hershey Corp.; and an aluminum radiator made by Harrison Radiator Division's new aluminum brazing process. Movies were supplied by Bell Aircraft Corp. and Trico Products Co.

Speakers were Lawrence Saunders, director of research for Harrison Radiator Division of GMC, who described the application of aluminum brazing to new light-weight radiators; Carl Maundrell, of Twin Coach Co.'s Buffalo Division, who told of quick tooling and rapid organization that have brought production of Fageol safety motor coaches up to 85 a month; Fred E. Ullery, executive engineer of the Houde Engineering Division, who spoke about the company's various damping devices; Steven Ellgren, chief of Bell Aircraft Corp.'s sales department, who told of Bell's plans to keep as intact as possible its large war-born organization through a research and development program in cooperation with the military, building of helicopters for all purposes, and subcontracting and manufacturing work; and William Warren, of Trico Products, who described a number of power devices, now on the market, for opening and closing windows on automobiles, convertible tops, and doing other jobs.

Chicago Section Holds Fourth Yearly Playday

by J. E. KLINE, Field Editor

CHICAGO Section, Sept. 12 – Chicago Section's 1947-1948 season was officially opened with the fourth annual playday and golf outing . . . the event again being staged, as in prior years, at Westward Ho Country Club. In terms of attendance figure, noise-making,

golf and door prizes, and other criteria normally applied to gage the success of such an affair, playday this year set a new high. A total of 338 members and guests attended. As last year, roast of beef was the headline attraction of the dinner menu, and, although not quite the rarity of a year ago, it was acclaimed unanimously by ravenous golfers and nongolfers alike.

The program was smoothly and efficiently executed by a hardworking committee under the joint chairmanship of Orville A. Brouer and George E. Hammel. The awe-inspiring display of golf and door prizes that greeted guests as they entered the clubhouse attested to the effectiveness of the committee's efforts. Fifty prizes were awarded to winning golfers, and the balance distributed as door prizes.

Golf competition consisted of 18-hole rounds, with net scores computed according to the rules of the Peoria handicap system. The Pretzel Benders, that perennial quintet of musical pranksters, were again on hand to amuse, heckle, and otherwise divert the 225 eager golfers who entered the competition. There were the usual beer holes for thirsty golfers, with liquid refreshment sponsored by Batavia Body Co.

Les Lear, the theatrical agent who is now a familiar figure at the annual playday affair, opened after-dinner entertainment with his customary humor. After winding up his funny stories, he introduced Russ Conlin, who sang Irish ballads and led the group in community singing that brought out some unbelievable vocal efforts from various parts of the room. He proved as adept at story telling as at singing, and raised a howl from the audience with his story of the leprechaun and the potato masher. Bill Walsh's band provided musical background for the evening's festivities.

Radio star Jim Ameche was on hand to distribute prizes. First golf prize for members went to W. G. Myers for his low net score of 65. He won a poker table and cover donated by the U. S. Thermo Control Co. Low score of 64 won for Non-member D. J. Stafford a set of three golf woods given by the Diamond T Motor Car Co.

The hard-working committee consisted of Chairman Brouer, Swift & Co.; George E. Hammel, Studebaker Corp.; Section Chairman W. W. Davies, United Air Lines, Inc.; Robert H. Brouk; James T. Greenlee, Imperial Brass Mfg. Co.; Frank W. Haase, Illinois Bell Telephone Co.; E. W. Lager, Voltz Bros., Inc.; George C. Stevens, Diamond T Motor Car Co.; A. H. Winkler, Bendix Products Division, Bendix Aviation Corp.; Austin W. Stromberg, "Power Wagon"; Arthur M. Hazell, Cudahy Packing Co.; Robert J. Temple, Jim Hills Co., and Henry Sirotek, Illinois Auto Electric Co.

CHICAGO PRODUCTION BANQUET

SAE Speakers Climax Machine Tool Congress

by J. E. KLINE, Field Editor

CHICAGO Section, Sept. 25 – A dinner at which SAE President C. E. Frudden was an honored guest and coffee speaker, SAE Production Vice-President Stephen Johnson, Jr., was toastmaster, and Joseph Geschelin, Chilton Co., principal speaker, marked SAE's participation in the gigantic Machine Tool Congress in Chicago, Sept. 17-26.

Sponsored by the Chicago Section in cooperation with the SAE Production Activity, the dinner, held on Sept. 25 at the Knickerbocker Hotel, was the closing event of importance on the Congress program. Chicago Section's Program Chairman W. H. Oldacre introduced the group of distinguished members of the Section Governing Board at the speakers table and then turned the meeting over to Toastmaster Johnson. Introduced by Oldacre were Chicago Section Chairman W. W. Davies; James T. Greenlee, National Sections Committee member; R. D. Kelly, vice-chairman for Aircraft; and Paul H. Oberreutter, treasurer. Davies closed the meeting with a few appropriate comments.

The close liaison between engineering and production was stressed by President Frudden. So closely allied are they, Frudden said, that the engineering job usually is but half done when the production job begins. He extended a special invitation to dinner guests to attend the SAE National Production Meeting held in Cleveland late in October.

Reviewing developments revealed by the machine tool displays at the Congress, Geschelin said that tool designers definitely are looking ahead . . . anticipating long-range trends. "They know first hand what is going on, what

Guest speaker at Chicago Section's banquet held Sept. 25 in conjunction with the Machine Tool Congress was Joseph Geschelin (right), Detroit editor of Chilton Co., who interpreted the Congress and its significance. Stephen Johnson, Jr. (above), 1947 SAE vice-president for Production Activity, served as toastmaster.

production people are thinking, what the metal-working industry wants," he said, adding: "They have anticipated the rise in direct labor costs, shifts in labor supply, increases in cost of raw materials."

Geschelin sees introduction of the automatic transfer type machine as the most daring forward step in machine tool design, and predicted that the automotive industry may possibly be adopting such machinery on a major scale in time for start of the 1948 production programs.

Chief characteristics common to most makes of machines at the Congress, he said, include:

1. Complete automaticity of machines intended for high production;
2. Features of automatic loading and unloading by means of magazines and loading and unloading mechanism of every description;
3. Automatic sizing;
4. Close control of dimensional tolerances on most makes through improved spindles, increased power, greater rigidity;
5. Wider use of electronics for controlling intricate cycles;
6. Flexibility, through built-in semi-automatic functions;
7. Flexibility, through features of design making for quick change-over from one job to another;
8. More complete trend to proper utilization of cemented-carbides and other hard-cutting tools;
9. Definite trend to surface grinding of exceptional finish and flatness in keeping with present-day requirements;
10. Advanced types of crankshaft and camshaft turning machines;
11. Improvements and wider scope of surface broaching machines; and
12. Major improvements in equipment for producing quality automotive gears.

"Why Pneumatics?" Starts Vigorous Section Discussion

by REX TAYLOR, Field Editor

SAN DIEGO Section, Sept. 26 – Over 100 members and guests attended this meeting to hear discussion of a phase of pneumatics new to these meetings. "Why Pneumatics?" or "The Case for Pneumatics for Intermittent Control of Aircraft" was written by H. F. Gerwig and H. F. Schmidt of Consolidated-Vultee Aircraft Corp. and presented by Gerwig. Members responded to the subject's novelty by holding a lively discussion after the paper.

The speaker explained the many advantages, weight- and safety-wise of the pneumatic system over electric and hydraulic systems. Fire hazard is completely eliminated, operation time is faster, and the medium, air, is free and always present. The system is charged on the ground, and can be recharged during flight by a small unit. Gerwig said a pneumatic starter can be built to weigh only 22 lb as against 100 lb for an electric starter.

Motion pictures of the Consolidated XB-46 showed the pneumatic system in operation, in flight and on the ground. Bill Martin, Consolidated test pilot, commented on his experiences with the XB-46, both in taxiing and in flight, expressed his pleasure with the pneumatically-controlled accessories of the XB-46 both in taxiing and in flight.

Piston Speed, Not Lag Called Engine Speed Limit

by F. E DeVORE, Field Editor

MID-CONTINENT Section, Oct. 3 – This Section's first meeting of the season was held in Stillwater, with the Oklahoma A&M Student Branch. Lloyd E. Johnson, staff engineer in Caterpillar Tractor Co.'s Research Department, spoke on "Directing Fuel to Air for Combustion in an Engine."

Comparing various types of internal combustion engines, Johnson pointed out that the spark ignition has the advantages of cheapness, simplicity, and reliability, but requires manifold heat for vaporizing fuel, so that volumetric efficiency is lowered and there are conflicting requirements for good idling and for "wide open" performance.

The fuel injection spark ignition engine overcomes these difficulties, he said, but requires all the accessories of both the diesel and the electric ignition engines. The "dual-fuel" engine, which uses some fuel with a low cetane number such as natural gas, with injection of high cetane fuel to provide ignition, does not throttle air, and has poor combustion efficiency at part load. In addition, if the heat value or cetane number of the fuel varies, the engine is subject to abuse.

There are a large number of possible variations of diesel combustion chamber design, Johnson said, pointing out the important requirements of proper fuel stratification, rapid mixing, simple injector maintenance. While each engine type has its own peculiar advantages and problems, the "pre-combustion chamber" type has the advantage of being able to use a simple single orifice injector that is not sensitive to variations in injection pressure and is easy to maintain. While friction and cooling water losses tend to run rather high, these are offset by early fuel burning in the cycle. Proportions of the combustion chamber are critical, but once perfected, the engine gives good performance at all speeds, and the chamber tends to remain clean. Precombustion chamber scavenging compares favorably with other types.

Ignition lag has been found to be closely related to degrees of crankshaft rotation rather than time, eliminating the necessity of variable timing devices. Ignition in a test engine took place in about 3 deg of crankshaft rotation at 2000 rpm, and lag is not believed to be a ceiling on engine speed.

Replying to questions, Johnson expressed the opinion that the limiting factor to increasing performance with a single-stage supercharger is the high temperature of intake air which lowers volumetric efficiency. With multiple-stage installations and intercoolers there is no such limitation.

Regarding maximum speed obtained, he said an experimental engine operated at 4800 rpm was limited by piston speed, not ignition lag.

Asked about varying precombustion chamber temperatures with changing loads, he said this was not a problem in Caterpillar's own design, but that they were developing some elaborate instruments for determining instantaneous temperatures. Because of low

FRUDDEN SAMPLES

SAE President Frudden spent two days in Colorado during his tour of West Coast Sections. On Aug. 27, a typical western dinner, furnished by Dean Gillespie at his mountain lodge near Evergreen, was served to Frudden and 75 Colorado Group members. The following day, Mr. and Mrs. Frudden and their daughter Phyllis were taken on a scenic

side thrusts in pumps, they have found no difficulty in operating them with very low viscosity fuels such as gasoline. Wear in the fuel system is nearly always simply a matter of dirt.

In conclusion, Johnson said that enthusiasm is a necessary requisite for a research engineer to carry him over rough spots . . . but that he should temper it to the point where he is not blinded to defects in his ideas.

Reports Strengthening of Internal Wrenching Bolt

by W. A. DAY, Field Editor

WICHITA Section, Sept. 11 – During the early days of development on the B-29 Superfortress, a need was found for stronger internal wrenching bolts. A. G. Arundale, of Boeing Airplane Co., told at this meeting how his company, in conjunction with the National Aircraft Standards Committee, conducted research to develop the ultimate in bolt design and manufacturing technique.

This problem was approached, he said, by first developing threads of maximum strength and then perfecting design and manufacturing technique to make the head as strong and fatigue-resistant as the threads.

A ½-in. diameter bolt was selected as a representative size for the program. Fifty specimens were used in each of the many tests to establish minimum, average, and maximum values, which were plotted on S-N curves.

He said that cut, ground, and rolled thread specimens of various alloy steels were tested. Tried next were hot-forged, cold-forged and broached socket heads with rolled, shotpeened and sandblasted fillets. The last three processes were tried in the fillets in order to induce a residual compressive stress at the point of greatest stress concentration.

Arundale explained that rolling of the fillets displaced some material that caused considerable difficulty with protruding rings at each end of the rolled surface, also that shotpeening and sandblasting meant stripping the bolts of cadmium plating. This required hydrogen embrittlement-relieving after replaiting, and involved considerable experimentation since the conventional time and temperature procedure did not give the desired results.

Summarizing test results, Arundale displaced test specimens and S-N charts, and said that the best bolts were made from NE 8740 steel with cold rolled threads, wherein there was a slight root radius which died out gradually into the shank.

Socket heads were cold-forged and broached with sandblasted fillets. The bolts were replaced and embrittlement-relieved at 400 F for 15 hr.

In discussion following his paper, Arundale stated that:

1. Quality control is essential;
2. Growth resulting from sandblasting is negligible;
3. Results vary on different diameter bolts;
4. There is much research still to be done on the subject.

WESTERN HOSPITALITY

tour through Estes park (where they are pictured at far right), over the famous Trail-Ridge Road and back to Denver through Grand Lake by Merle J. Webber, chairman, and Marcellus Merrill, program chairman. Frudden and Webber are shown below at left.

Frudden visited Spokane-Intermountain Section Aug. 5 and 6. He is shown below in an informal after-meeting discussion with members of the Student Branch from the State College of Washington at Pullman.

Tests Aimed at Bettering Variable Pitch Propeller

by J. H. CARPENTER, Field Editor

WILLIAMSPORT Group, Oct. 6 – Recent changes to improve action of variable pitch propellers for light aircraft were described at this meeting by L. J. Trigg, chief engineer of Sensenich Propeller Co.

Trigg described construction of the governor and pitch change mechanism, and showed by slides how the governor controls the flow of engine oil through the propeller shaft to a plunger, which imparts movement to the blade butt to change the pitch setting. He said also that recent design changes would replace the plunger with a diaphragm. Blade counterweights, necessary until recently, are being eliminated. Other changes are aimed at reduced weight and cost and simplified servicing.

Variable pitch propeller, he said, has the advantage of increased propeller and engine efficiency, since it permits optimum throttle and mixture settings for cruising. The weight of the propeller pitch control mechanism is approximately 3 to 4 lb greater than that of a fixed pitch propeller.

In the open forum following Trigg's presentation, discussion centered on the slow-speed multi-blade propeller. Trigg explained that principal objective is noise reduction, but that tests are being conducted to determine what further advantages can be obtained with this type of installation.

Tour Opens Met Season

by C. F. FOELL, Field Editor

METROPOLITAN Section, Sept. 17 – Nearly 100 members of Metropolitan Section attended an inspection tour of the Navy's Special Devices Laboratory at Sands Point, L. I., N. Y., from 2 to 4 P.M. today, at the invitation of Capt. G. M. O'Rear, USN, in charge of the establishment.

Groups of six to eight were given detailed explanation of the various pieces of equipment developed to quickly train non-technical recruits in navigation, piloting, flight engineering, gunnery, bombing, and other tasks. The devices are made available to Navy training schools.

They range from simple mechanical gadgets to complicated electronic instruments to simulate actual flying conditions.

A group of Section members is shown at the lower left.

Shown below at right is a group who participated in the technical meeting that evening in the Hotel Pennsylvania.

Urge Design Mating Machines to Humans

by CHARLES FOELL, Field Editor

METROPOLITAN Section, Sept. 17 – Growing complexity of modern machines – particularly the airplane – places greater responsibilities on the engineer to tailor the machine to man. To this theme were keyed talks by Com. N. A. M. Gayler, Lt.-Com. G. W. Hoover, and Dr. L. C. Mead, of the Office of Naval Research's Special Devices Center, at Sands Point, Long Island.

All three speakers warned that aeronautical engineering progress already is evolving aircraft requiring two-headed and four-armed pilots. To turn the coming tide of such airborne monsters, they urged the engineer to apply human engineering – design shaped to man's anatomical, physiological, and psychological capabilities and limitations.

Inattention to human anatomy, Mead said, shelves more than one piece of equipment. Every engineering department produces at least one such Rube Goldberg that calls for a freak operator combing the virtues of the circus "thin" man, "India rubber" man, and "strong" man.

Physiology lights the way to knowledge of muscular coordination between various body members for operating equipment in this study of man-machine relationships. From psychology the engineer can learn about man's mental processes and behavior.

To reap the rich harvest promised by human engineering, we must first develop through basic research those factors telling human abilities in terms of which the engineer can design suited-to-man equipment. For example, physical factors in the working environment greatly influence man's performance and efficiency. For this reason determinations should be made of optimum levels of temperature, humidity, color, noise, vibration, motion, acceleration, air pressure, light, and color.

Com. Hoover showed this thinking to be particularly important in supersonic flight. Already current aircraft are knocking on the door of Mach 1. But from present indications the supersonic pilot will have to be found from among other than earth-bound men – unless the airplane is modified to carry Mr. Average Man.

This supersonic flight problem is being attacked on two flanks: (1) to find human physical limitations so they may be applied to aircraft design and (2) to determine ways of increasing the human threshold so that aircraft design limitation are minimized.

Special research tools must be built to produce these answers, said Com. Gayler, commandant of the Special Devices Center. He described one such device, a centrifuge on a 50-ft arm that develops 40 g at the rate of 10 g per sec and simulates any environmental conditions at any altitude. The human guinea pig in the centrifuge will undergo a complete physical and neurological check-up while under test.

Gayler pointed to research in mass training methods as another phase of the operations at the Special Devices Center. A film he showed described some of the synthetic trainers developed by this organization that a group of nearly 100 Metropolitan Section members saw at Sands Point that afternoon. Both the trip and meeting were arranged by J. I. Hamilton, vice-chairman for Aeronautics.

Shows Climate's Effects On Fuels and Lubricants

by ARNOLD R. OKURO, Field Editor

NEW ENGLAND Section, Oct. 7 – There is about 90 F difference between the temperature at which gasoline will allow a car to start and the temperature at which it will cause vapor lock. Speaking in Boston, a city that knows what is meant by extremes in temperature. W. G. Perriguey of Standard Oil Co. of N. J. explained that from a practical standpoint, gasolines can be designed that will meet reasonable climatic requirements of each New England season.

While starting and vapor lock are controlled by the temperature at which 10% of the gasoline has evaporated, Perriguey said, the 50%-evaporation temperature controls warmup time. Temperature at which 90% of the gasoline evaporates is a good criterion for dilution and distribution: the higher the temperature required, the

Met Section at Sands Point

Shown at Metropolitan Section's Sept. 17 symposium on U. S. Navy research on special training equipment and instrumentation are (l. to r.) Dr. Leonard C. Mead, Com. N. A. M. Gayler, Lt.-Com. G. W. Hoover, and J. I. Hamilton, Met Section vice-chairman for Aeronautics, who presided.

more dilution and the poorer distribution that will result.

Vapor lock, he said, results when the pump is required to handle mainly gasoline vapor instead of liquid gasoline. Since the pump can handle only a given volume, and gasoline volume is greater as vapor than as liquid, the mixture that goes to the carburetor and the engine is too lean to permit engine operation. Vapor lock may result, too, if gasoline forms puddles in the intake manifold, as it may on a warm day when an attempt is made to restart a warm engine and gasoline percolates through the carburetor. Closed choke and wide throttle usually cure this.

Good distribution means that all the gasoline-air mixture that goes to the various cylinders of an engine has the same composition. Poor distribution means rich outer cylinders, with soot formation and abnormal washing away of the cylinder-wall lubricant by unburned gasoline; and lean inner cylinders with consequent high temperatures, possible detonation and exhaust valve burning.

Perriguey discussed effects of air temperature, coolant temperature or compression ratio changes on octane requirements, showing by charts that a small change in any of these may raise octane requirements by several numbers.

Perriguey described the extensive test programs perfected during the war to evaluate performance of lubricating oils and fuels under low-temperature operating conditions, and showed how they explain many of the unsatisfactory operating conditions experienced in the field. Proved to be of importance were not only engine temperatures, but also adequate crankcase ventilation, and minor variations in design, manufacture, or assembly, even of the same model. Thus minor differences in metal thickness, clearances and other factors have been known to account for differences greater than 100% in ring zone deposits and sludge.

Tests measuring effect of variations in crankcase temperature on FL2 test results have shown that an increase in crankcase oil temperatures of 10 F can reduce sludge deposits by 50%. A 10 F increase in water jacket temperature decreased sludge deposits 17%. An increase in crankcase oil temperature reduced insoluble resins in the lubricating oil 57%, and crankcase dilution 32%. Increasing jacket water temperature resulted in a 70% reduction in insoluble residues, and a 14% reduction in crankcase dilution.

Heavy-Duty oils, Perriguey reported, will perform the function for which they were designed, particularly in dispersion of fuel soot. But they cannot be expected to absorb the vast amount of contamination the engine puts into the oil. Nor can Heavy-Duty or any other lubricating oil be expected to function adequately if abnormal quantities of water or fuel dilution are present in the crankcase.

Coffee talk was presented by Sewall Fogg Richardson, of General Electric Co., who spoke on "Modern Speed Airplanes."

Richardson said "We are now living in the age of speed. We want to go fast in everything. We demand high speeds in our trains, in our buses, our automobiles and our airplanes. We even have electric pigs to speed up our garbage disposal."

He went on to describe the project that culminated in clocking the world's speed record of 650.6 mph, when Major Marion Carl flew a tiny jet-propelled Douglas Sky Streak. The Sky Streak, he said, uses a single General Electric designed and built Model TG 180 aircraft gas turbine, similar to the design that may in the not-too-distant future be powering our commercial airplanes. It is one of the two airplanes today that is designed specifically for investigating the problems of structure, powerplant and human reactions at the high-speed level. The other is the Bell XS-1, which is rocket-propelled.

While military aircraft research proceeds at a much greater pace for obvious financial reasons, such war-born devices as radar, ultra-high-frequency radio, automatic pilots are all appearing now on commercial planes.

But factors affecting high speed commercial operation, Richardson said, are somewhat different . . . cost-versus-return is the primary consideration: cost of development of both airplane and powerplant for higher speeds must be offset by demand for faster transportation by the public.

The next logical step toward higher speed is use of gas turbine type engines with jet propulsion, since reciprocating engine-propeller type powerplants reach their peak of usefulness at about 500 mph. It may be five or ten years before jet propelled transports are in general commercial use. Life is relatively short, fuel consumption high.

Richardson's predictions:

1. Present-day transport aircraft speeds will not increase much beyond 400 mph;

2. From five to ten years hence, gas-turbine-powered jet propelled airplanes will be used for carrying passengers and cargo with cruising speeds of 500 to 600 mph. He guesses there will be no requirements for transport speeds above 600 mph for inter-continental travel based on the difference in time zones between east and west coasts. That is, there would be no point in making a transcontinental trip under five hours unless trips were scheduled to depart in the early morning hours . . . or unless the Pullman policy of allowing passengers to board planes in the early evening were adopted.

Bob Lybeck's long and faithful Section service as Sectional representative and past-chairman was recognized at this meeting when he was presented with a gift of golf clubs, bag and golf balls by the Section's "Old Timers."

Irvin Fogg Richardson, railroad service engineer of Socony-Vacuum Oil Co., Inc., introduced Perriguey.

Ford Engineering Head Urges Designers: Look at Customers' NEEDS . . . Not WANTS

by W. F. SHERMAN, Field Editor

DETROIT Section, Oct. 6 – Thinking on passenger car design was sharpened at the opening session of this Section when Harold T. Youngren, vice-president and director of engineering and research of Ford Motor Co., aimed the microscope at the past and translated findings into terms of the future.

The meeting was held at the famed Greenfield Village, Edison Institute Museum, where hundreds of examples of past automotive achievements are on display. More than 500 attended dinner at Dearborn Inn before the technical session.

Highlights of Youngren's address, which was concerned with the fact that automotive engineers must recognize the public's needs, included:

"Passenger car design is affected by many things. Lumped together, I would describe these as the NEEDS . . . not WANTS of the public. Too many have learned too late that people buy what they need . . . not always what they want.

• Ride: "Today an ever-mounting need for a better ride has the industry on its toes. Rides are going to get better as the automobile continues to evolve into an honest-to-goodness room on wheels."

"We must produce cars having more comfortable seats, better vision and ventilation, particularly in bad-weather driving."

• Shape of car to come: " . . . While the passenger car in its original form was designed to carry both people and things . . . the need for carrying things is going to play an increasingly important role in determining the shape of cars to come. More and more the passenger car is becoming a room on wheels. To me that spells wider, roomier cars with ample luggage space.

"Smooth, flowing lines are a must. Fortunately, good aerodynamic design and beauty are compatible. Function-

turn to p. 86

SAE Section Chairmen

This is the third installment in this year's series of Section Chairmen biographies. More will appear next month.

JACKMAN

. . . . of Spokane-Intermountain

George A. Jackman has a talent for tackling difficult jobs and producing results that has made him a valuable asset to United Truck Lines. In 1932, when he took over the duties of shop superintendent, United was a small struggling freight operation between Spokane and Seattle, with five trucks on the highway. It was Jackman's business not only to nurse these five vehicles along and keep them rolling, but also to keep drivers on the job. The company grew and prospered when it was able to maintain schedules; more units were added each year until the system now has over 300 trucks operating throughout the Northwest.

Early in its career, United Truck Lines saw the necessity for increasing payload on the western haul from Spokane to the Coast. In as much as packing houses in Spokane furnish most of the meat products for the Puget Sound region, an in-transit cooling system was seen to be a big source of additional revenue.

This problem was thrown in Jackman's lap. He and his associates solved it, after some unsuccessful experiments with dry ice, natural ice, and refrigerated steel slabs, with mechanical refrigeration that didn't break down under occasional schedule delays. He gave a paper on "Truck Refrigeration" before Spokane Section in 1944.

Jackman's automotive education was acquired as apprentice to a Spokane automobile dealer. After seven years, at 22, he moved into the heavier field of mechanics in the maintenance department of the Interstate Coach Co.

He has been too busy during these past 15 years to devote much time to hobbies, but does like to slip away occasionally for a good fishing trip. More recently he has taken up flying, and we hear he now flies to the fishing grounds.

– by Tom Barker, Field Editor

George A. Jackman

CHARSHAFIAN

. . . . of Metropolitan

Jack O. Charshafian has been one of Met Section's most active members since he joined the Society in 1939. He has been vice-chairman for Aeronautics, Student and Membership Activities, secretary to the Governing Board, and vice-chairman. In 1940, when he was Membership Committee head, he was instrumental in establishing a record of 326 new Section members.

Introduced to Metropolitan Section activity several years ago through the Junior Advisory Committee, composed of younger members of the Section, Jack has always brought to meetings of subsequent Boards the viewpoint of new members. His keen analysis of prospective papers has always been helpful in planning for the Section's technical meetings.

He is one of the original – and most enthusiastic – proponents of the panel-type meetings. His efforts last year as chairman of the Panel Committee were largely responsible for the success of the program.

He joined the engineering staff of Wright Aeronautical Corp. in Wood-Ridge after his graduation from the Polytechnic Institute of Brooklyn in 1936. His first job was test observer, tester, and test engineer in the Experimental Department. As project engineer during the War, he worked on development of the Cyclone C-18 model engine used in the B-29. He was recently elevated to his present position of manager of the Special Propulsion Division.

During the past several years he has been an instructor at his alma mater.

– by Charles Foell, Field Editor

Jack O. Charshafian

MOLLOY

. . . . of Southern New England

Richard C. Molloy just about lives aeronautics. His ardor isn't much dampened by the fact that he discovered, while still at M.I.T., that flying is not only a lot of fun but also a rich man's sport, and that his glider spent more time being repaired than it did flying.

However, his love of aircraft has manifested itself in the formation of a social aeronautical group at M.I.T., and in his hard work as Southern New England Section's vice-chairman for Aeronautics last year. He is also a member of IAS.

Dick joined United Aircraft Corp. in 1935, first as assistant aeronautical engineer and then aeronautical engineer in the Research Department, then as technical chief of the Wind Tunnel Laboratory. He is now executive research engineer. At United he is best known for his prominent part in designing the wind tunnel, which has interchangeable 8-and 18-ft test throat sections and is the largest privately-owned wind tunnel in the world.

His active hobbies are color photography, swimming, and writing articles – and he has some fairly unusual ideas about the engineer's responsibilities in national and world affairs.

– by A. M. Watson, Field Editor

Richard C. Molloy

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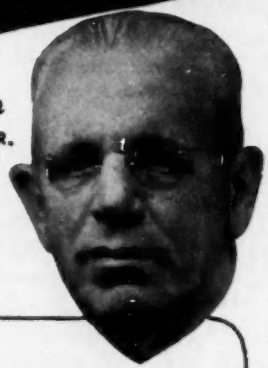

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Section News

cont. from p. 83

ally and esthetically there is a need for better styling. I say functionally, because as cruising speeds go up good aerodynamic design becomes increasingly important.

• Shape of Engines to Come: "I believe the V-8 engine and horizontal opposed-type or pancake-shaped engines will become increasingly popular because of their compactness, ease of accessibility, and simplicity of design. I believe the trend in this direction is unmistakable."

• The Gasoline Engine Or . . . ? "The gasoline engine is the best type we now have. Will it retain its present popularity? . . . I am told we Americans are consuming gasoline at the rate of 31 billion gallons a year. Do we have sufficient quantity available to meet these – and possibly greater – demands? I don't know the answer to that question, but I do know that it is going to be a potent factor in determining the kind of need we will some day have to consider."

• Rear Engine Drive: "Immediately preceding the war and at the present time the placing of the motor at the rear has invited a lot of speculation. Many European cars have engines mounted in the rear and at various

Silicone News
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DC Silicone Fluid Solves Toughest Damping Problem

PHOTO COURTESY THE ELLIS SALES CO.

Constant Viscosity of DC 200 Fluid in Ellis "Contourliner" makes contour plowing easy and accurate.

A new, ingenious device made farm paper headlines recently when the Ellis Sales Company of Fairfield, Iowa, announced the "Contourliner"—an instrument for scientifically maintaining accuracy in contour plowing.

Previously it has been necessary for the farmer to survey his field, and put stakes along the contour line to serve as guide marks when plowing. The "Contourliner" eliminates all this extra work. Mounted on the hood of the tractor in plain view of the driver is an easy-to-read dial calibrated to show which way the tractor is deviating—to show how much in per cent of slope—to tell the driver which way to turn to get back on the contour.

Since tractors travel over extremely rough ground, a damping fluid was needed to prevent tractor vibrations from interfering with the accuracy of the instrument. The problem was to find a damping fluid that would retain a constant viscosity over a wide range of temperatures.

Many different types of oils were first tried as a damping fluid. Temperature variations, even during a normal summer day's operation, so changed the viscosity of these oils that accurate indication was impossible.

DC 200 fluid, suggested by Dow Corning engineers, proved to be the answer. Since DC 200 fluid has the ability to maintain almost unchanged viscosity from —40° F. to 400° F., it was of course unaffected by seasonal temperature changes. Stability under all types of conditions is a common characteristic of all Dow Corning Silicone products, including resins, varnishes, greases, and Silastic*, our silicone rubber. Dow Corning Silicone products are described in Catalog D 1-5.

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times quite a few American cars have employed the feature. Should there occur a definite need for a vehicle of this type the rear engine drive may again reappear on the American scene."

• Front Wheel Drive: "As with the rear-engine drive, the front-wheel drive design offers some interesting possibilities. Low overall height and possibly reduced weight are advantages of both. Low, racy appearance is still one of the primary advantages of the type."

• Aluminum: "The idea of using aluminum in place of steel is as old as the industry itself. Until recently the major obstacle was cost.

"There is far greater need for lower cost than for light weight.

"Cost is still a major stumbling block in the widespread substitution of aluminum for steel in automobile construction.

"The present steel shortage . . . coupled with the necessity for sustained automobile production, has prompted Ford and other manufacturers to explore every possibility of employing aluminum wherever practicable on present production models.

"It is costing us more money, but it is saving us steel, and it enables us to build more cars. The extent to which we will go in the use of the metal depends on the gravity of the steel shortage and its duration."

• Mechanical Aids – Steering: ". . . is already a problem in the bigger cars because of the increased weight on the front end. In all probability we eventually will see luxury models equipped with auxiliary power steering aids.

"Great strides are now being made in this respect, but the surface is barely scratched. Some may be extra-cost items at first – but if the need is great enough you can be certain we engineers will produce them."

Youngren's talk was illustrated with kodachrome slides and the vehicles which provided the illustrative material were on exhibit in the Musuem outside the auditorium.

Before the technical talk, Ernst R. Breech, executive vice-president of Ford, declared: "This is the time when bold resourcefulness and brilliant conception on the part of the automotive engineers is our greatest need. The public expects real improvement from you and I hope that they are not going to be let down."

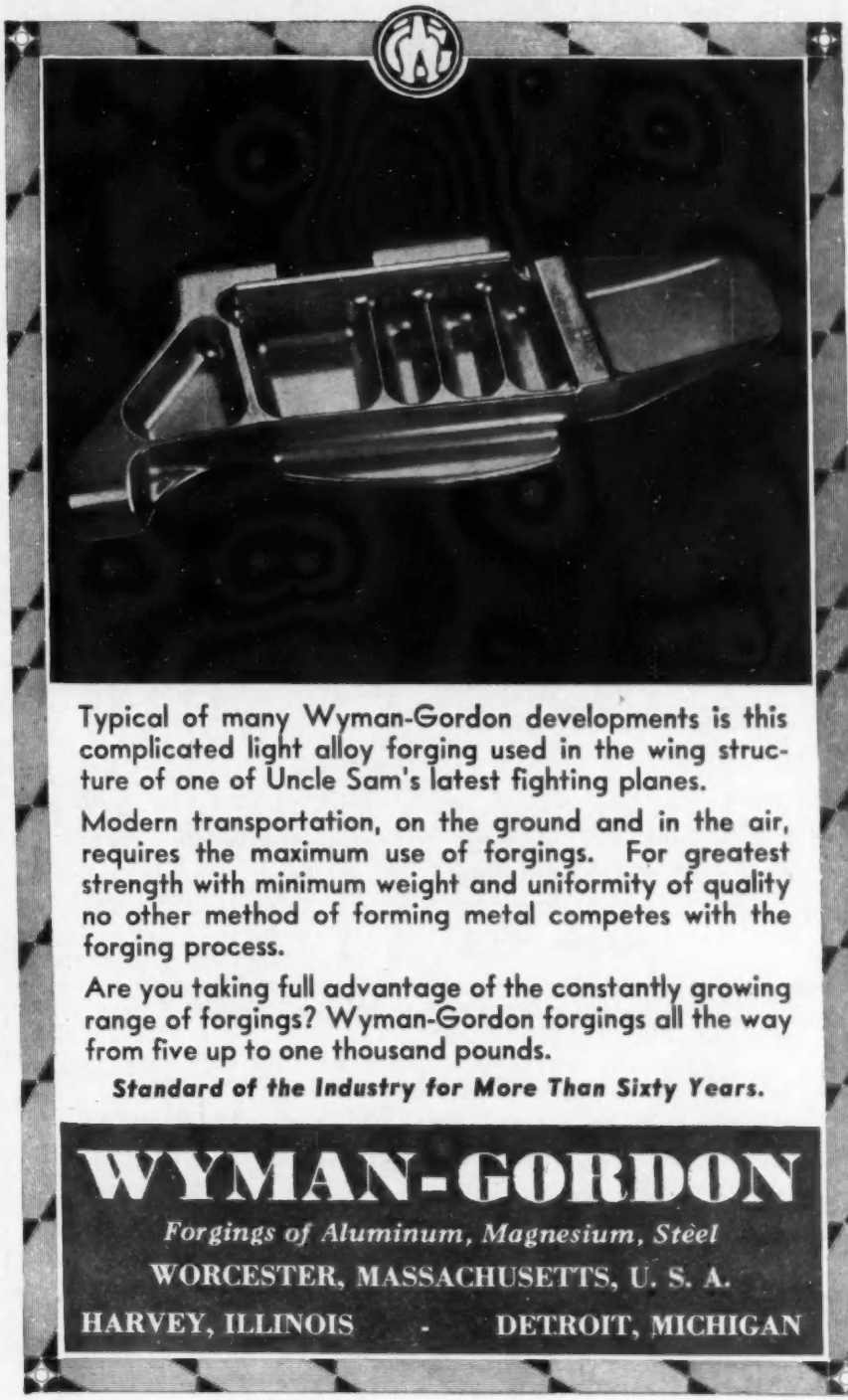
He urged that young engineers be sought out, placed in the industry's laboratories and given a chance, to see what they can come up with. Scientists, he said, should be induced to come into the industry. Older engineers with know-how and experience should sift out the practicable ideas.

He cited improvements "expected by our customers in their postwar cars," including automatic transmissions. From his own aircraft experience he cited examples of engineering developments that should challenge automotive engineers. Air friction on the skin of jet propelled airplanes at 600 mph raises the temperature 75 F, he said. Then he offered:

"How is the aircraft industry solving this problem? A turbo-driven refrigeration system has been developed by bleeding the air from the turbo-compressor with very little addition to the weight of the plane. Compare this problem from every standpoint with that of airconditioning an automobile. Compare again the problem of pressurization of an aircraft cabin with that of keeping an automobile dry inside during a heavy rain."

After the meeting, those present stayed as long as they liked to inspect Museum exhibits. Departing from regular practice, Musuem authorities had hoods unlocked so the antique cars could be inspected in detail, not just viewed as museum pieces.

At the speakers table were John A. C. Warner, SAE secretary and general manager; M. H. Wahlberg, Nash; R. E. Cole, Studebaker; Henry Ford II, Ford; J. M. Crawford, General Motors; J. C. Zeder, Chrysler; B. G. Roos,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Robert Insley, Section chairman, presided, and SAE Past-President W. S. James, vice-chairman for Passenger Car Activity, introduced the speaker and handled the question and answer period.

Expert Explains Why Carburetors Ice

by A. K. MILLER, Field Editor

ST. LOUIS Section, June 10 – E. E. Dean, a 40-year veteran of carburetion engineering, told members at this meeting why they may be plagued with carburetor icing in their automobiles and what to do about it. Dean was research engineer with Carter Carburetor Corp. until his recent retirement.

Trouble arises, Dean said, from pressure differentials above and below the throttle. When a motor is operating, space below the throttle, including intake manifold, will have very low pressures – equivalent to 18 to 22 in. of hg – and these low pressures will extend perhaps as far as 30 mph into the speed range. Pressures above the throttle will be nearly atmospheric.

During idle speed, the opening around the throttle may be less than 1/64 in., and even at 30 mph the opening will be comparatively small. This high pressure air above the throttle will pass around the throttle at very high velocities and quickly expand into the zone of low pressure below the throttle, causing a temperature drop.

Fuel coming from the idle passage will also pass through the idle passage outlet at high velocities and become broken up mechanically into very fine particles, and will be vaporized by absorbing heat from the surrounding air. This will cause a further temperature drop.

Since the carburetor is a rather efficient form of refrigerating device, Dean explained, ice will form rapidly under certain conditions around the throttle plate, beginning opposite the port side and gradually extending around the plate's outer periphery. If the motor is allowed to run at partly closed throttle for a few minutes, ice will completely bridge the gap between throttle and bore, shutting off all air to the motor so that the motor stops. This condition will be most troublesome when air temperatures are about 35 to 50 F and before the throttle plate has reached temperatures above freezing.

Answer to the problem, he said, is to live in an uncongested neighborhood where there is no need for stopping before the car is warmed up, and ice cannot close the throttle opening, or to adjust the dash throttle for a little faster idle speed so that more ice will be required on the throttle before the motor will quit.

Colorado Group Meeting Discusses Kettering Paper

by KENNETH G. CUSTER, Field Editor

COLORADO Group, Sept. 26 — "The performance factors of high octane fuel and higher compressions are more important than the economy factors," D. G. Hubbard, of Continental Oil Co.'s Engineering Service Department told members at this meeting. Hubbard's discussion followed reading of C. F. Kettering's paper "More Efficient Utilization of Fuels." (See SAE Journal, July, 1947, p. 31).

Hubbard said, "The octane value of gasoline has been climbing since 1930 and will continue to climb. The high compression engine with still higher octane ratings will be accomplished by gradual changes rather than any sudden move. Each engine requires a certain octane gasoline and there is no advantage in going higher.

"Manufacturers of gasoline and manufacturers of engines have always worked together to keep octane rating and compression ratios in balance. Any big change in compression ratio to allow nation-wide fuel economies is not necessary at present, since the shortage of fuel, other than the present temporary shortage caused by production difficulties, is a myth. Gasoline manufacturers have enough sources of synthetic fuel ready to use whenever necessary to prevent anticipation of a fuel shortage."

Student Branch News

Northrop Aeronautical Institute

At the Institute's July 10 meeting, L. J. Pare of the Materials and Processes Department of Northrop Aircraft, Inc., described the work of that department. He said that the Materials Engineering Section is responsible for publication of the company's Materials Manual, and for the preparation of all specifications for outside purchases. The Processes Engineering Section determines correct procedures for the manufacture of aircraft components and publishes the results in the Processes Manual. This section is responsible, too, for preparing all finished specifications and for assisting the production departments in planning any new or unusual fabrication methods. A special duty of the department is the supervision of all resistance and fusion welding done at the plant.

•

Steps required in the design and manufacture of the new Bauman Brigadier, a two-engined personal air-

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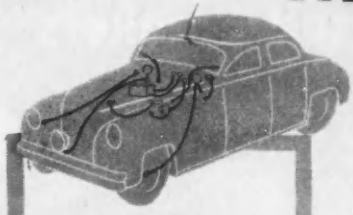

TYPICAL AUTOMOTIVE APPLICATIONS

POWER DRIVE
- Movable Tops
- Speedometers
- Taximeters
- Truck Recorders
- Windshield Wipers
- Truck Cranes
- Air Conditioners

REMOTE CONTROL
- Choke Valves
- Clock Reset
- Trip Odometers
- Drain Valves
- Engine Governors
- Radios
- Radio Antennas
- Spotlights
- Heaters

One of the problems in engineering motor vehicle designs is the location of accessories. Accessories that require remote control complicate the problem. The same is true for accessories that require rotary power drive.

Fortunately, S.S.White flexible shafts provide a really simple solution to this problem—a solution that saves time and money because of their extreme simplicity and ease of application. With one of these shafts you can transmit power or provide remote control between any two points in a motor vehicle. This gives you complete freedom in placing both accessories and controls anywhere you want them.

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It gives complete facts and engineering data about flexible shafts and their application. A copy is yours if you write for it on your business letterhead and mention your position.

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plane, were outlined by J. Bauman, of Bauman Aircraft Co., at the Aug. 14 meeting of the Northrup Student Branch.

Bauman said that 4000 man-hours were required for design, and 6000 for fabrication, of the prototype airplane. Original design specifications called for two engines of the light-plan class, as it was felt that they would be readily available in large quantities and at a reasonable per-hp cost. In addition, two engines would give greater safety in case of engine failure. Another feature of the design was installation of pusher propellers to enable passengers to enter the cockpit with no danger of walking into propellers. Engines and accessory sections are located in front of the main wing spar and are accessible for maintenance.

Bauman's talk convinced students that safety, dependability or performance is responsible for incorporation of any idea in the design of a new airplane . . . never mere newness or uniqueness.

•

How to obtain a Type Certificate for a new airplane was explained to students at their Aug. 21 meeting by George W. Holdeman of the CAA's Aircraft and Components Branch. After the CAA receives a request for a certificate, Holdeman said, three groups of inspectors, the airframe and equipment group, the powerplant group, all start making checks of the design and fabrication of the experimental plane.

He told how the design and performance calculations of the company are checked, and strength tests made of the various structural components. The first model is flight-tested to determine its stability in flight, its control characteristics, and its ability to meet CAA performance requirements. After all tests are approved and the Type Certificate is issued for the design, a Production Certificate can also be issued if the company's production and inspection methods are satisfactory.

– by Leon M. Warne, Field Editor

The NEW FASCO SNAP-MOUNT Circuit Breakers

Exclusive Snap-Mount Design...

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Rensselaer Polytechnic Institute

Austin M. Wolf, consulting engineer, was on hand at the RPI Student Branch's first meeting, Sept. 11, to discuss automotive suspension and powerplant placement.

Describing and comparing American and foreign vehicles, Wolf outlined basic principles of suspension system design as affected by the mass ratio of sprung to unsprung weight. The mass distribution of a vehicle, he explained, is governed by forces exerted as it travels.

With descriptive sketches and diagrams, he explained different positions of engine mountings, their comparative advantages, and the engineering problems each poses. Innovations in automotive design, he declared, appear almost exclusively in foreign cars, while the American vehicle tends to be stereotyped.

Over 150 students were joined by faculty members and guests from the SAE Mohawk-Hudson Group to make an overflow meeting that had to be moved to a larger hall. Welcoming the audience to the first SAE function of the term, Chairman Eugene Zak announced that the organization has been formally chartered as an SAE Branch by the Council.

– by Howard Roberson

Fenn College

With Fenn College growing as never before in its history, the first meeting of the SAE Student Branch appropriately had as speaker Sholto M. Spears, dean of the School of Engineering, to speak on "Expansion of Fenn College."

Spears explained how development of this program grew largely out of knowledge gained during the war. Administration was simplified and department heads given more time and authority. Day and night school pro-

grams were standardized along with admissions.

Teaching staffs and facilities are constantly expanding. Number one priority belongs to a new million-dollar mechanical engineering building.

During the question period, emphasis was on the important role of personality in engineering success

– by Robert P. Buhrow, Field Editor

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between Sept. 10, 1947, and Oct. 10, 1947.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: Arthur N. Curl (M), Marcel Albert Lamoureux (J), William M. Meyer, III (J).

British Columbia Group: Arthur Fred Rees (A).

Canadian Section: Frank Wakefield Adams (A), James Irving Carmichael (M), George M. Davies (A), John Crawford Martin (A), Marvin B. Mendelson (J).

Chicago Section: Ivan G. Anderson (M), Bjorn F. Benson (M), John Wendell George, Jr. (J), Delmar C. Klawitter (M), James Norton Low (J), Lloyd A. McCormick (M), Elton F. Nichols (J), Herman G. Portman, Jr. (M), Steven F. Rams (A), Loring F. Shoemaker (A), Arthur J. Sturwold (A), Val B. Suarez (J), John E. Thompson (J).

Cincinnati Section: Clarence D. Johnson (J).

Cleveland Section: J. J. Baadte (A), Nathan H. Biddle (A), Paul L. Cairns (M), John Michael Pawlechko (J), William H. Rowe (J), Harry Robert Urban (J), Howard C. Worden (M).

Dayton Section: John Willyoung Janson (J), G. LaVerne Runkle (M), Lloyd Duane Yates (J).

Detroit Section: H. Dean Clark (A), Wm. A. Clark (M), Donald J. Fitzpatrick (A), William F. Heise (J), Edwin J. Johnson (A), Robert P. Kelly (M), Miss Eugenia P. Konopka (J), Heber C. Lamar (A), Max H. Leavenworth (A), Donald C. MacMillan (J), W. H. Messner (A), Charles H. Morris (M), Harold Johnston Morris (J), A. W. Reinhardt (J), Robert A. Sforzini (J), Sterling Joseph Spleet (A), William C. Vincent (M), George H. Wetterhahn (J), Richard H. Wheeler, Jr. (J).

Hawaii Section: Leland E. Copple (M), Wallace L. Doty (A), Marshall H. Owens (A), Thomas Francis Pryor (A), John Edgar Walker (M).

Indiana Section: Wendell Cooper Compton (A).

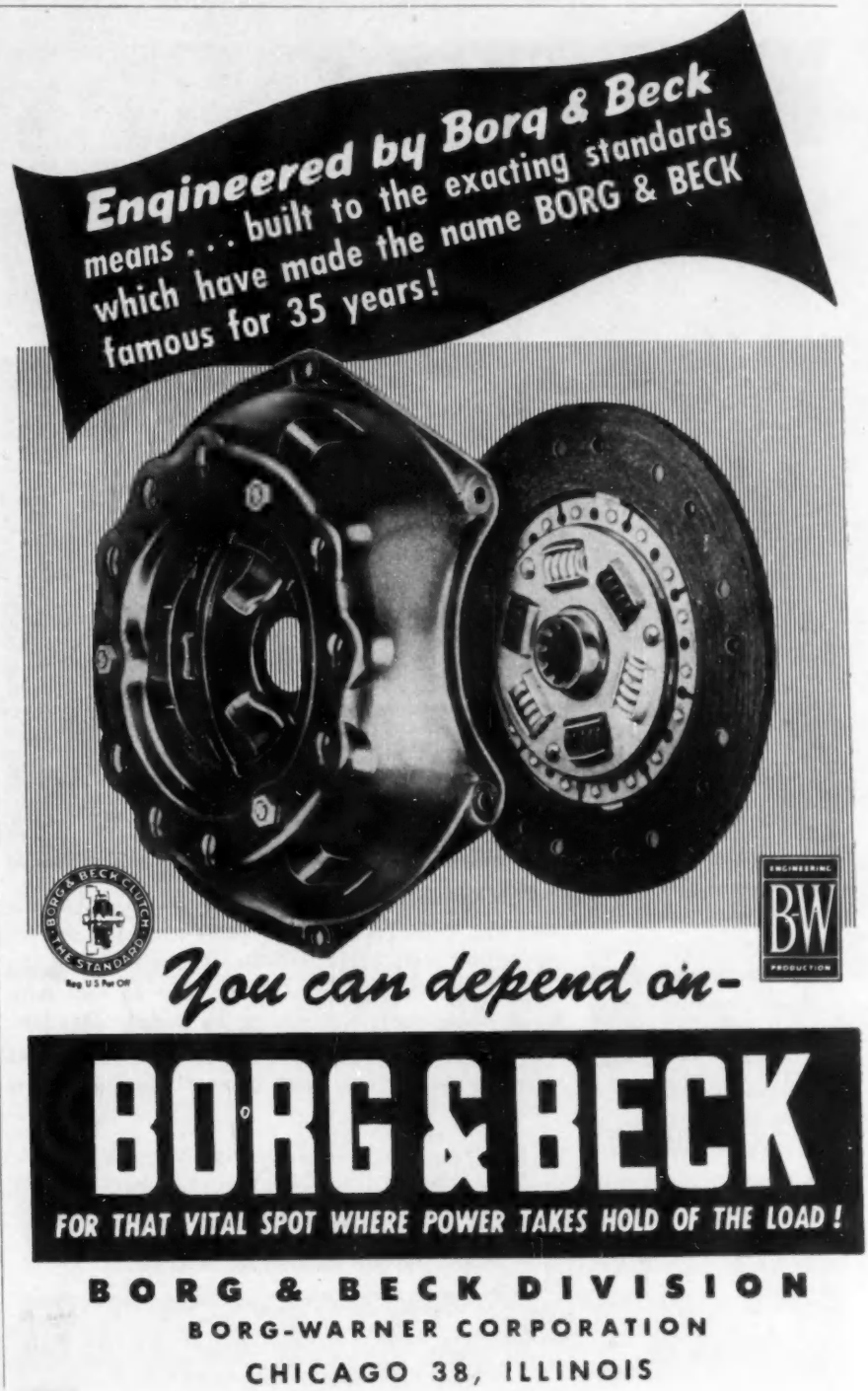
Kansas City Section: F. R. Grant (M).

Metropolitan Section: Orlo Jay Blomquist (J), George J. Dashefsky (SM), Robert James Foley (J), Andrew P. Gregg (J), Harry Kee (J), Howard I. Margerum (A), Andrew V. Martin (M), Alberto Marx (J), Milton Menkus (J), Frank E. Mott (A), Gerard Paquin (J), Robert R. Porter (M), David J. Seigel (A), William Sternlicht (J), Douglas Courtenay Watson (J), Paul E. Weingart (M), Harry E. Zust (M).

Milwaukee Section: Robert Carlin (J), J. A. Fries (A), Rene Joseph Gehl (J), H. V. Kilpatrick (A), Paul Walker Lathan, Jr. (J), Benjamin Rush McConnell, Jr. (J).

Mohawk-Hudson Group: T. G. Milton (A), Arthur J. Rose (A).

New England Section: William B. Jackson (A), Kenneth M. MacDowell (J), Wellington Greeley Rodgers (A), Thaxter A. Williams (A).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Northwest Section: Joseph F. Cornell (M).

Oregon Section: D. F. Davis (A).

Philadelphia Section: Rudolph Birmann (M), Fitzhugh Lee Duer, Jr. (J), Alfred C. Joy (M).

Pittsburgh Section: Wayne W. Carter (J), H. A. Klein (A).

St. Louis Section: Kenneth C. Baker (M), Ben Nichols (A), Alex N. Swargulski (M).

Southern California Section: Steve A. Beisert (A), F. Besancon (M), Matthias V. Christman (M), Jack R. Clements (A), Harry de Lapotterie (M), Wetmore Hodges, Jr. (M), Dr. Maurice Nelles (M), Ralph S. Newcomer (M), Henry G. Smith, Jr. (M), Jay Wm. Stuart, Jr. (J), Charles G. Wright (M).

Southern New England Section: Donald Peard Kay (J), Howell W. Miller (M), John V. Moffitt (M).

Syracuse Section: E. E. Baldwin (M), William James Skinner (M).

Texas Section: Virgil L. Ackerman (J), Lee P. Livingston (A).

Twin City Section: Walter H. Clausen (M), Sidney Howe Crowell (M), Douglas E. Fahlen (J), Wayne Byron Johnson (M), James Frederick Sullivan, Jr. (J).

Virginia Group: John L. Frank, Jr. (A).

Washington Section: A. F. Notley (SM).

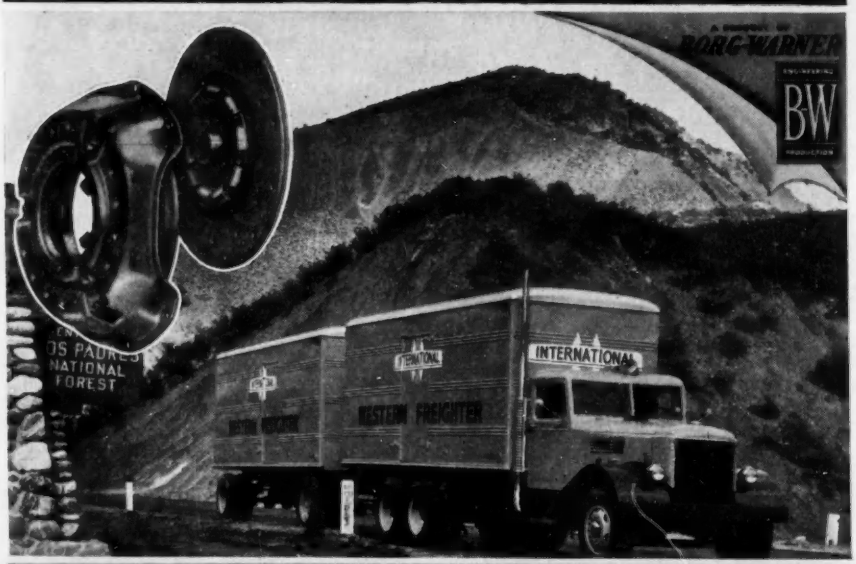
Western Michigan Section: James E. Jones (M), Herbert P. Lindrup (J), Earl C. St. Amour (J).

Wichita Section: John B. Hardee (A), John M. Maloney (A), H. A. Mayor, Jr. (J).

Outside of Section Territory: David Holland Bradford, Jr. (J), David Wallace Dinsmore (J), Louis E. Endsley (M), John H. Gerstenmaier (M), R. L. Jones (M), John M. Kelly (J), Gilbert Roth (J), Joseph Trepanowsky (A), Dudley W. Watkins, Jr. (J), Wm. F. White (M), A. G. Wyrick (A).

Foreign: H. M. Ainsworth (FM), France; Claude Walter Lionel Baily (FM), England; William Read Bendall (FM), England; Capt. Fernando Alberto de Oliveira (FM), Portugal; Mohammed Ibrahim Fawzi (FM), Egypt; Walter D. Follis (FM), South Africa; Raymond George Frederick Griffin (J), England; Arthur Halliday (FM), England; "Maquitrans" Maquinaria y Elementos de Transporte, SA (Aff.), Spain; Rep: Sebastian Nadal; Capt. Paget McCormack (FM), Ireland; Mortimer Hulme Rigby (J), England; Cecil Stuart Roberts (FM), England; Bernard Eric Treganowan (FM), England.

ROCKFORD



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Applications Received

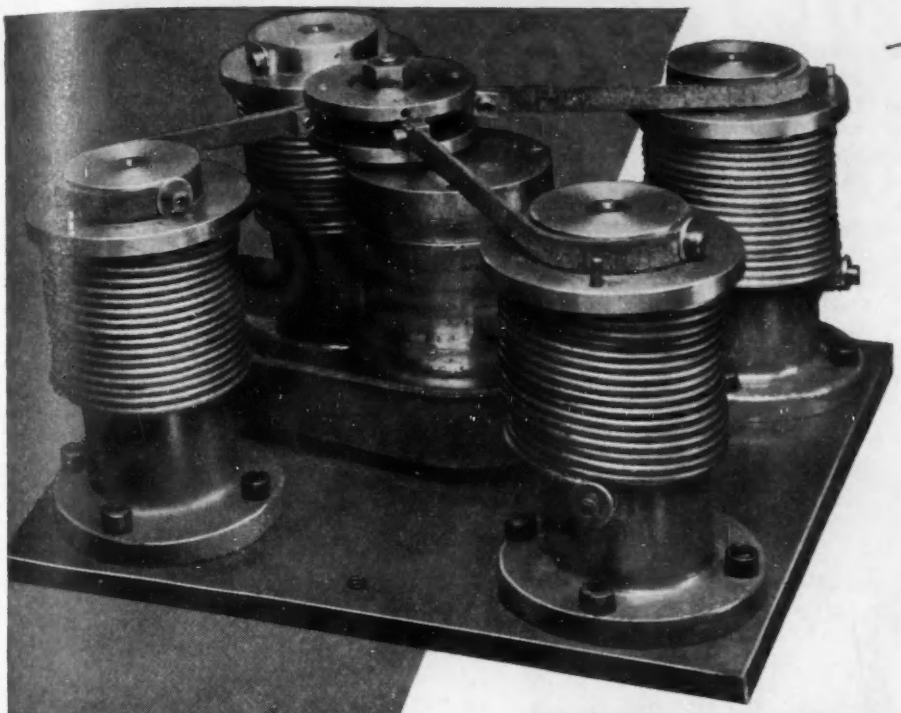
The applications for membership received between Sept. 10, 1947, and Oct. 10, 1947, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

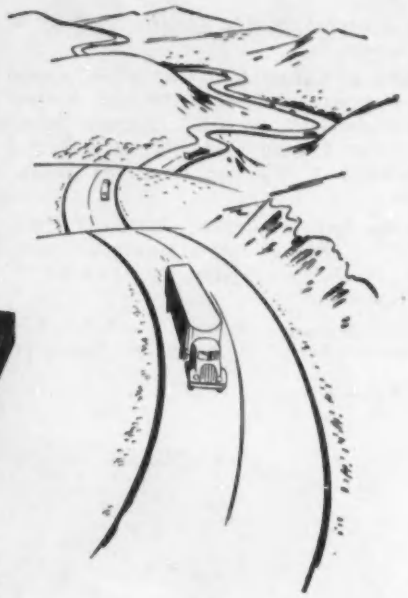
Baltimore Section: Abraham Jacobson, Samuel A. Whitehead.

British Columbia Group: Thomas Lionel Coulthard, Kenneth Logan Hall.

Canadian Section: Colin Edwin Morrison.

Chicago Section: Earl G. Boudreau, Hugh St. Clair Christian, Robert William Fleming, Arthur Harvey Ledyard, Carl Frederick Lindee, Jr., Seth T. McCormick, William Repenning, Alfonse





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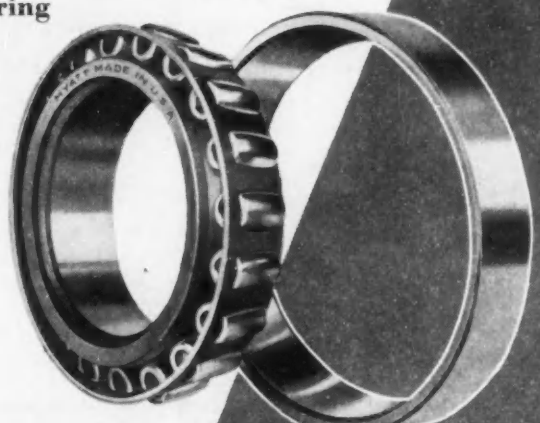

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Dayton Section: Lewis Richard Catt, Paul C. Hanlon, Lewis Albert Leonard, Jr., Krell Earl Spires, Jr., Donald H. Whiston.

Detroit Section: Robert Frederic Andrews, William P. Balthrop, James D. Bettridge, William Earl Bice, Neil L. Blume, Kurt B. Boehm, Joseph P. Busher, Thomas Chlebina, Jack Jacob Cornell, Walter C. Curtis, Chester Gabrael Ferens, Harvey Seldon Freeman, Duncan B. Gardiner, Gordon Arnold Gettum, William Edgar Gore, Donald Milton Hollabaugh, Ralph H. Isbrandt, George E. Kentis, Jr., Ralph C. Lord, Jr., Max Frederick King, Jerry J. May, Carl H. Meile, Harry R. Mitchell, Robert George Rajala, Donald Joseph Sachs, Howard Edward Scharfenberg, George Wilson, Arthur P. Zaske, Jr.

Indiana Section: Dale Allen Hasler, George Thomas Kuhn, Darrel E. Peugh.

Kansas City Section: George W. Wells.

Metropolitan Section: Richard Henton Daily, John M. Cole, Kenneth C. Fitzpatrick, Frederick J. Hart, John Perry Mayberry, Joseph J. Meehan, Hyman M. Mizell, Elfried F. H. Pennekamp, William E. O'Neill, Elliot L. Taylor, Daniel D. Todes, William Van Rosenbergh, Paul R. Wagner.

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New England Section: Victor J. Baxt, Alfred H. Johnson, E. Earle Whitney.

Philadelphia Section: A. W. Bass, Jr., Maurice A. Hutelmyer, Eugene Potter Ryan, Charles B. Weiler, Louis H. Winkler.

Pittsburgh Section: James Edward Cumiskey, Arthur E. Slagle.

Northern California Section: W. Edgar Martin, Fred C. Hall, Ernest L. Hargrove, Harold H. Hunt, Berent Nathaniel Knutsen.

St. Louis Section: Walter Odro Cralle, Jr.

San Diego Section: Corbus Roy Barber, Edwin David Hayward.

Southern California Section: Weldon Beck Allbaugh, Frederick Arthur Dobbratz, Don D. Doty, Virgil F. Simonick, Marshall C. Wood, Jr.

Southern New England Section: E. Marston Moffatt, Miss Gertrude Elizabeth Parks, Robert H. Webster.

Syracuse Section: Carmen D. Cianfione.

Virginia Section: William Berle Hubbard, Charles L. Young.

Texas Section: Z. N. Baker, Robert Herrick Kolb.

Western Michigan Section: Arka M. Shanks.

Outside of Section Territory: Robert C. Forman, Richard Ernst James, Robert Carson Johnson, William Lee Leonard, Jr., John C. Miles, Justo A. Odriozola, John D. Selin, Milton V. Smith, Steve Zelisko.

Foreign: Jacques Alliet, France; Ronald Baily-McEwan, So. Africa; William Frank Bolton, Gold Coast Colony; Percy Scott Bramwell, British West Indies; Mincho Alfred Dalmau-Pichardo, Dominican Republic; Howard C. Daudet, Netherlands West Indies; Peter Victor Dunn, South Africa; Colin Gordon MacKenzie, England; Joseph R. Roda, Brazil; William Henry Slack, England; Hans Rudy Steffen, Switzerland.

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